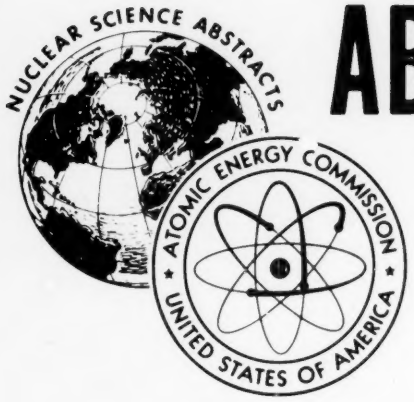
NUCLEAR SCIENCE ABSTRACTS



Volume 27 Number 1

Abstracts 1-2307

January 15, 1973

UNITED STATES ATOMIC ENERGY COMMISSION

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CORRECTIONS

The abstract numbers on pages 5121–5127, Volume 26, Issue 22 are in error. All abstract numbers on these pages should be increased by one thousand.

Volume 27, Number 1, January 15, 1973

NUCLEAR SCIENCE ABSTRACTS

A semimonthly publication of the USAEC Office of Information Services, John A. Harris, Director.
Published by the USAEC Technical Information Center, Robert L. Shannon, Manager.

Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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A list of the journals scanned regularly and the abbreviations used appears in the January 15 issue of *Nuclear Science Abstracts* and is supplemented in the July issue. The January 15 issue also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts*. The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts*, available free from the USAEC Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/81b-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
  determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution, 25:251(P)
TRIETHYLENETETRAMINE
  complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
  content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
  content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
  determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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21	25-261	Dep. NTIS
30(Pt.2)	25-331	Dep. NTIS
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78	25-1912	Dep. NTIS

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Volume 27, Number 1, January 15, 1973

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 1580.

1 (MLM-1903) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT: JANUARY-MARCH 1972. (Mound Lab., Miamisburg, Ohio). 20 Oct 1972. Contract AT-33-1-GEN-53. 25p. Dep. NTIS.

^{230}Th and ^{231}Pa recovery from St. Louis residues, triple point problems in Pu chemistry, suggestion for study of Pu in environmental waters, neutron activation analysis for oxygen in solid steel rods and in hollow steel cylinders, tritium determination in air by liquid scintillation counting, and spectrographic analysis of solution samples are discussed. (M.C.G.)

2 AVTOMATICHESKIE ANALIZATORY RADIOKHIMICHESKIKH SRED. (Automatic Analyzers for Radiochemical Agents). Second Edition. Shelemin, B. V. Moscow; Atomizdat (1971). 456p.

Automatic systems for assaying radioactive materials are reviewed with a discussion of the principles involved, technical requirements, and technical characteristics taken from published material. Topics discussed include: radiochemical extraction, nuclear fuel reprocessing, radioactivation, Moessbauer spectra, absorption processes, pH meters, electrical conductivity, coulometry, luminescence photometry, NMR, and α, β, and γ radiations. (583 references) (K.S.W.)

3 CONTAMINATION PROBLEMS IN TRACE-ELEMENT ANALYSIS AND ULTRAPURIFICATION. Robertson, D. E. (Battelle-Northwest, Richland, Wash.). pp 207-53 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Some of the major sources of contamination most frequently encountered in trace-element analyses or purification procedures are evaluated. The discussion is presented under the following section titles: preparation and physical manipulation of samples; contaminants in purified reagents; materials and equipment; chemical manipulations; and determining the presence of contamination. (71 references) (J.G.B.)

4 GLASS CONTAINERS FOR ULTRAPURE SOLUTIONS. Adams, P. B. (Corning Glass Works, N. Y.). pp 293-351 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

The nature of glass surfaces and reactions between the surface and various chemicals are discussed as they relate to container glasses that might be used to store or handle ultrapure solutions. Only those reactions between glass and aqueous solutions at temperatures between 0 and 100°C are considered. It is possible to predict with varying degrees of certainty interactions that occur. Major chemical constituents and trace elements usually present in container glasses are tabulated. (46 references) (J.G.B.)

5 METHODS OF AIR SAMPLING AND ANALYSIS. Washington, D. C.; American Public Health Association (1972). 497p.

The book is composed of three main parts, general precautions and techniques, tentative methods of ambient air sampling and analysis, and recommended factors and conversion units for analysis of air pollutants. The methods section deals separately with carbon compounds, halogens and halogen compounds, metals, oxidants and inorganic nitrogen compounds, particulate matter, radioactivity, and sulfur compounds. A subject index is included. (J.G.B.)

6 EXTRACTION OF CHELATE COMPOUNDS. Zolotov, Yu. A. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers (1970). 324p. $22.50.

Translation of Ekstraktsiya Vnutrikompleksnykh Soedinenii by J. Schmorak.

The fundamental principles of analytical applications of chelate extraction are presented. Specific subjects treated include the techniques of increasing the selectivity of the extraction, ways of effective combination of the extraction with subsequent determination methods, characteristic features of the extraction of this class of compounds, and radiochemical methods. Emphasis was placed on the general theory of chelate extraction, on extraction of coordination-unsaturated and charged complexes, and on methods of determination of the composition of extracted compounds. (M.C.G.)

Activation and Nuclear Reaction Procedures

Refer also to abstract 861.

7 (BNL-17215) AUTHENTICATION OF PAINTINGS BY RALPH A. BLAKELOCK THROUGH NEUTRON ACTIVATION AUTORADIOGRAPHY. Cotter, Maurice J.; Meyers, Pieter; van Zelst, Lambertus; Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). 1972. 29p. (CONF-720920-3). Dep. NTIS.

From second international conference on forensic activation analysis, Glasgow, Scotland (27 Sep 1972).

Neutron activation autoradiography was used to examine and aid in identification of oil paintings. The paintings were irradiated with a thermal neutron flux of 10^9 neutrons/cm^2/sec, and gamma activation was measured periodically using a Ge(Li) detector. Autoradiographs were recorded on x-ray and blue- and uv-sensitive commercial film. Sodium, potassium, chlorine, and strontium were present in the paint pigments in significant quantities. (J.G.B.)

8 (CONF-721002-1) NUCLEAR AND X-RAY TECHNIQUES. Lyon, W. S. (Oak Ridge National Lab., Tenn.). 1972. 14p. Dep. NTIS.

From Interagency conference on the environment; Livermore, CA. (17 Oct 1972).

Nuclear and x-ray techniques provide some of the most powerful analytical methods available for the examination of environmental pollution samples. A number of the U. S. Atomic Energy Commission and National Aeronautical and Space Agency laboratories have developed capabilities in these areas to the stage where they can now accept assignments from other agencies (such as the Environmental Protection Agency) to perform specific analytical services. A number of these proved techniques that have been applied to environmental problems are discussed. Neutron, photon, and charged particle activation analyses are examples of nuclear techniques already successfully used in pollution studies. X-ray fluorescence, induced by x-rays or charged particles, can provide elemental analysis at low cost. Electron spectroscopy for chemical analysis can provide specific chemical information about toxic elements. A few specialized techniques are also mentioned: the use of stable isotopes in environmental studies, spark source mass spectrometry for multi-element analysis, and sorption chromatography for the determination of trace organics in water. All of these methods are presently being applied and examples of data obtained from their use are given. (auth)

9 (JPRS-57372 (pp 17-49)) RADIOACTIVATION ANALYSIS AT THE "BORIS KIDRIC" INSTITUTE. Draskovic, Rade; Dras-

kovic, Radmila. Translated from Tehnika (Belgrade); No. 4, 761-8; No. 3, 1597-1603(1972). NTIS.

Research projects in the field are reviewed to indicate the possibilities for use of radioactivation analysis. Results from activation analyses are presented for: determination of impurities in Ge and GeO_2, analysis of limestone from deposits in Yugoslavia, determination of impurities in polyethylene and Teflon, and analysis of suspended sediments and waters of the Danube. Radioisotope purity, radioactivity as function of intensity of neutron fluxes used in irradiating gold foil, and radioisotope contamination of aluminum cans used as containers in reactor irradiation are also discussed. (M.C.G.)

10 (KURRI-TR-98) SHORT-TERM RESEARCH REPORTS ON ACTIVATION ANALYSIS USING COMPUTERS. Tamai, Tadaharu (ed.) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 10p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Activation analysis presents many advantages, including high sensitivity, applicability to nondestructive techniques, adaptability to automation, and the use of a single sample for the determination of several elements. These features have been greatly enhanced during the last few years by the introduction of semiconductor detectors for γ radiation and by the increasing use of electronic data processing. The report contains two short-term research projects in this field. The first paper presents a review on the use of lithium-drifted germanium detectors in combination with computerized data processing as applied to environmental contamination problems involving the atmosphere and rivers. The second paper covers the automation of flux monitoring, still emphasizing the usefulness of germanium detectors and computerized data processing. (TTT)

11 DETERMINATION OF SMALL AMOUNTS OF ANTIMONY IN PIG IRON BY NEUTRON ACTIVATION ANALYSIS (EXCHANGE OF EXPERIENCE). Vinokurova, L. A.; Dolgov, V. M.; Drugachenok, M. A.; Salamatov, I. I.; Khramchenkov, A. I. (Inst. of Nuclear Physics, Moscow). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 1, 62-3(Jan 1972).

Translated from Zavod. Lab.; 38: No. 1, 51-2(Jan 1972).

A neutron activation method for determining antimony in pig iron is presented for which standard specimens were fabricated from two pig iron melts with chemical compositions corresponding to commercial types used in automobile and tractor construction. The antimony concentration was determined by comparing the difference in the total counts for specimens with and without antimony added (background) and the standard over the energy range 470 to 670 keV. The maximum possible total analytic error did not exceed 7% and was produced principally by the spectrometer instability, the change in counting rate from specimen to specimen, and the inaccuracies in standard preparation. The concentration sensitivity for determination of antimony in specimens of pig iron weighing 100 mg was 5 μg/g, or 5×10^{-4}%. (D.H.M.)

12 ULTRAPURITY: METHODS AND TECHNIQUES. Zief, Morris; Speights, Robert (eds.). New York; Marcel Dekker, Inc. (1972). 714p. $37.50.

Twenty-two chapters are included; separate abstracts were prepared for eight. The remaining 14 chapters contain information on: purification of organic solvents by frontal-analysis chromatography; preparation of pure sodium and potassium; sublimation of phosphorus pentoxide; purification of proteins by membrane ultrafiltration; purification of p-xylene by partial freezing; purification of isopropylbenzene by preparative gas–liquid chromatography; preparation of ultrapure chemicals by fractional distillation; purification by dry-column chromatography; preparation of ultrapure water; preparation and characterization of cholesterol; airborne contamination; high-purity chemicals—a challenge to practical analysis; visible spectrophotometry; and coulometric titration. A section on information sources for ultrapurification and characterization included in the appendix was also abstracted separately. Separate author and subject indexes are included. (P.C.H.)

For abstracts of individual chapters see: 3, 4, 13, 14, 58, 59, 107, 150, and 621.

13 NEUTRON-ACTIVATION ANALYSIS. Kelly, John J. (Consolidated Edison Co. of New York, N. Y.). pp 535-56 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Various aspects of activation analysis are discussed, including physical principles, instrumentation, analysis techniques, and applications. Detection limits are given for the nondestruction determination of 73 elements. (59 references) (J.G.B.)

14 INFORMATION SOURCES FOR ULTRAPURIFICATION AND CHARACTERIZATION. Connolly, T. F. (Oak Ridge National Lab., Tenn.). pp 599-651 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Various information sources dealing with the ultrapurification and characterization of ultrapure materials are given. These include directories, specialized information centers, journals, and serials. References dealing specifically with ultrapurification and various methods of characterization, including activation analysis, neutron diffraction, mass spectrometry, etc., are listed. (J.G.B.)

15 DETERMINATION OF RARE-EARTH IMPURITIES IN YTTRIUM OXIDE BY NEUTRON ACTIVATION ANALYSIS. Upor, E.; Hohmann, J. (Mecsek Ore Mining Enterprise, Pecs, Hungary). pp 131-4 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844–(Vol.1).

A solvent extraction method for the separation of rare earth impurities in yttrium oxide was developed for use in conjunction with their neutron activation determination. Ce, Eu, Gd, Tb, Yb, and Lu were extracted from nitric acid solutions using HDBP and determined by the counting of γ activity. (J.G.B.)

16 DETERMINATION OF THE Cl/Br RATIO IN FLUID GYPSUM INCLUSIONS BY NEUTRON ACTIVATION. Sabouraud, Christiane; Bourrelly, I. N.; Touray, Jean-Claude; Deschamps, Norbert (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. D; 274: No. 24, 3161-3(12 Jun 1972). (In French).

Marine gypsums (originating from the Mara marsh of New Caledonia and the salt flats of Aigues–Mortes) were studied. The samples taken were irradiated between 30 and 60 minutes in EL3 with a neutron flux of 7×10^{12}n/cm^2/s. The chlorine and bromine were separated in the form of AgCl and AgBr. The γ radioactivity of these precipitates was measured. In spite of the low abundance of Cl and Br a precision of ± 10% and ± 15% was obtained for these two elements. (France)

17 RADIOCHEMICAL STUDIES ON EFFECT OF BATH. 1. DETERMINATION OF MERCURY IN SPRING MUD BY NEUTRON ACTIVATION ANALYSIS. Kawamura, Hiroko; Kawakami, Hiroyasu (Kyushu Univ., Beppu, Japan). Eisei Kagaku; 17: No. 4, 284-6(Aug 1971). (In Japanese).

The micro-amount of mercury in hot spring water in 45 places in Beppu spa, as well as mercury content in dried sludge and solution, was determined by neutron activation analysis. Kon-ya sulfur sludge which was found to have an accelerating effect on urinary excretion of mercury during hot spa treatment of alkylmercury toxicosis was examined. The content of mercury in the dry sulfur sludge was 15.4 ppM and more than 14.6 μg/liter in the liquid, naturally hydrated sludge (liquation rate, 9.5%). These results indicate that the mercury content is greater than that in other soils or in spa water. (Japan)

18 ACTIVATION ANALYSIS OF HUMAN HEAD HAIR. 2. INFLUENCE ON CONTENTS OF TRACE ELEMENTS BY WASHING HAIR SAMPLES. Kozuka, Hiroshi (National Research Inst. of Police Science, Tokyo); Tsunoda, Noriko; Isono, Hideo; Niwase, Takeshi. Eisei Kagaku; 17: No. 4, 265-9(Aug 1971). (In Japanese).

As one of fundamental experimental conditions in the activation analysis of human hair, examination was made on changes in the concentration of trace elements by washing hair samples. External contamination of hair samples was easily removed by washing with organic solvents but some manganese and sodium were washed out by this treatment. Easily water-soluble elements were removed by washing with a detergent or deionized water. Use of city water instead of deionized water resulted in absorption of zinc into hair samples. Washing of hair samples with organic solvents was adopted for examination of trace elements in human hair, because the washing procedure is easy, washing experiments can be repeated with minimum of error, and easily water-soluble components are useful for individualization of human hair. (auth)

19 ACTIVATION ANALYSIS OF HUMAN HEAD HAIR. 4. VARIATION IN TRACE ELEMENT CONTENTS IN HAIR WITH LAPSE OF TIME. Kozuka, Hiroshi (National Research Inst. of Police Science, Tokyo); Isono, Hideo; Tsunoda, Noriko; Niwase, Takeshi. Eisei Kagaku; 17: No. 4, 280-3(Aug 1971). (In Japanese).

Hair samples were first collected from three individuals every other day, then once a week, and finally once a month for three months and then analyzed by neutron activation. Variation in the concentration of trace elements in the hair samples with lapse of time was generally insignificant and smaller than the difference among individuals. The γ-ray spectra from the same

person showed analogous patterns which were characteristic in the individual. Concentration of trace elements in the hair from the same head maintained a constant level which seemed to be peculiar to the head hair. With one exception of the above-mentioned trends was a marked variation in the concentration of bromine in one person. This change was due to hair dressing and it was considered that a large quantity of bromine was absorbed in the form of bromate from the permanent waving agent. Increased bromine concentration decreased gradually and was reduced to the normal level after two months. (Japan)

20 STUDIES ON PHOTON ACTIVATION ANALYSIS. PHOTON ACTIVATION ANALYSIS BY THE $\gamma-\gamma$ SIMULTANEOUS COUNTING METHOD. Suzuki, Nobuo; Yokoi, Takeaki; Shibata, Hiroshi (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 115-21(Sep 1971). (In Japanese).

In order to establish a preferential method of determination of a desired element, the availability of the $\gamma-\gamma$ simultaneous counting method was examined. Lower limit of determination was determined for more than 10 elements. The results indicated that the efficiency of counting was much better than the simultaneous counting of the cascade γ rays, which show little dependence on the angle correlation. The samples used contained Fe, Co, Ni, Cu, Zr, Ge, Sb, Rh, Ti, As, Y, Ce, and Tm. The irradiation was made by an electron linear accelerator of 30 MeV for 1 hour each. The lower limits of determination were 3.4×10^{-2}, 2.1, 4.6×10^{-1}, 6.1×10^{-2}, 4.0×10^{-2}, 7.2×10^{-2}, 1.9×10^{-1}, 2.4×10^{-1}, 9.4×10^{-2}, and 8.5×10^{-1} mg for the (γ,n) or $(\gamma,2n)$ reactions of Ti, Fe, Co, Ni, Cu, Ge, As, Rb, Zr, and Rh, respectively, when the β^+ annihilation radiation was simultaneously counted. The limits were 8.7, 1.9, 7.0×10^{-1}, 4.4, 2.9, 3.8, 1.1×10, and 1.7 mg for the (γ,n) reactions of Co, Ni, As, Rb, Y, Sb, Ce, and Tm, respectively, and that for Ti, by the (γ,p) reaction was 1.7 mg, when cascade γ rays were simultaneously counted. (Japan)

21 STUDIES ON PHOTON RADIOACTIVATION ANALYSIS. PHOTON RADIOACTIVATION ANALYSIS OF FLUORINE. Suzuki, Nobuo; Yokoi, Takeaki; Shibata, Hiroshi (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 4: No. 1, 122-5(Sep 1971). (In Japanese).

A method for the detection of very small amounts of fluorine was developed. The method involves counting the 0.511-MeV γ-ray annihilation radiation of β^+ from ^{18}F with two detectors in 180° symmetry. This method is specifically sensitive compared with other simultaneous counting method, and has a selectivity to separate objective nuclides from radioactivities of coexisting nuclides. The sensitivity reduction by simultaneous counting is very small, so the application of this method is preferable. The calibration curve shows that actual measurement is expressed as $[^{18}F(cpm)]/[F(mg)] = (9.39 \pm 0.91) \times 10^2$ within all concentration ranges from 0.5 mg to 50 mg of fluorine. The line is especially fine and straight at above 10 mg of fluorine and expressed as $[^{18}F(cpm)]/[F(mg)] = (10.2 \pm 0.24) \times 10^2$. The discrepancy of radioactive intensities at ^{18}F is with 5%. The exact quantitative results can be obtained by this method even when organic substances or heavy metals coexist. (Japan)

22 ACTIVATION ANALYSIS OF HUMAN HEAD HAIR. 6. BLOOD GROUPING TEST OF HAIR AFTER IRRADIATION WITH NEUTRONS. Kozuka, Hiroshi; Ikemoto, Shigenori (National Research Inst. of Police Science, Tokyo). Eisei Kagaku; 17: No. 5, 330-2(Oct 1971). (In Japanese).

The possibility of a blood-grouping test utilizing hair samples previously irradiated with neutrons was investigated. Hair samples were collected from the individuals whose ABO blood group types were previously known by testing their blood cells. Irradiation of sample hair with neutrons was made for 1, 5, or 30 minutes from a pneumatic tube or for 5 hours in core, and integrated neutron doses were 4.7×10^{13}, 2.3×10^{14}, 1.4×10^{15}, and 3.8×10^{16} n/cm^2, respectively. The activity in blood grouping test of the samples tended to decrease and the error increased in proportion to the integrated neutron dose. It was concluded that the usual blood grouping test is possible after irradiation with 10^{15} n/cm^2 of neutrons as the maximum dose. (Japan)

23 NEUTRON ACTIVATION DETERMINATION OF IMPURITIES IN NIOBIUM USING SEMICONDUCTOR DETECTORS. Sukhov, G. V.; Firsov, V. I. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 368-71(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 297-9(Mar 1972).

A method is proposed for activation analysis of niobium and its pentoxide that does not involve preliminary chemical separation of the radioelements. Two semiconductor γ spectrometers have been used. The impurities determined were Na, Mn, Fe, Co, Zn, Cu, As, Mo, Ta, W, Cr, Re, Sb, Ce, Eu, Hf, Ir, La, and Au. (M.C.G.)

24 COMPUTER PROGRAM FOR PROCESSING GAMMA SPECTRA IN NEUTRON ACTIVATION ANALYSIS. Dubinskaya, N. A.; Yanson, Ya. V. (Inst. of Physics, Riga). J. Radioanal. Chem.; 11: No. 2, 339-49(Aug 1972).

A program based on the method of least squares and written in the ALGOL-60 code was developed for data processing in the activation analysis of biological substances. The applicability of the program was checked on synthetic mixtures of the radioisotopes ^{64}Cu, ^{69m}Zn, and ^{56}Mn measured with a scintillation γ spectrometer. (auth)

25 RADIOANALYTICAL METHODS FOR THE NONDESTRUCTIVE ANALYSIS OF LUNAR SAMPLES. Randa, Z. (Inst. of Mineral Raw Materials, Kutna Hora, Czech.); Benada, J.; Kuncir, J.; Vobecky, M.; Frana, J. J. Radioanal. Chem.; 11: No. 2, 305-37(Aug 1972).

The elemental compositions of Apollo 11 and Apollo 12 lunar soil samples 10084,141 and 12070,83 and Apollo 12 rock fragment 12063,73 were determined by nondestructive radioanalytical methods. Main mineral fractions and glasses separated from these samples were analyzed as well. Instrumental neutron activation analysis (INAA) was used to determine Na, Mg, Al, Si, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zr, Cs, Ba, La, Ce, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Tm, Yb, Lu, Hf, Ta, W, Ir, Au, Th, and U. A method of delayed neutron counting was used for the determination of uranium, and nondispersive radioisotopic x-ray fluorescence analysis was applied to the determination of Ti, Fe, Sr, Y, and Zr. (auth)

26 PROGRAM FOR COMPLETE QUANTITATIVE NEUTRON ACTIVATION ANALYSIS USING Ge(Li) DETECTOR GAMMA SPECTROMETRY AND A SMALL COMPUTER. Op De Beeck, J. P. (Ghent Univ.). J. Radioanal. Chem.; 11: No. 2, 283-303 (Aug 1972).

Large sophisticated programs designed for big computers can be efficiently used on medium scale machines for complete quantitative neutron activation analysis with Ge(Li) detectors. (auth)

27 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF PHOSPHORUS IN ROCKS. Das, H. A.; Zonderhuis, J.; Rose, R. (Research Reactor Center, Petten, Netherlands). J. Radioanal. Chem.; 11: No. 2, 273-81(Aug 1972).

The possibilities are discussed of instrumental activation analysis of phosphorus in rocks by the reaction $^{31}P(n,\gamma)^{32}P$ (T = 14.2 d). Results are given for six standard rocks of the U. S. Geological Survey. (auth)

28 MERCURY AND CADMIUM DETERMINATION IN WATER BY PROMPT (n,γ) METHOD: ^{252}Cf AS THE NEUTRON SOURCE. Handley, T. H.; DeCarlo, V. A. (Oak Ridge National Lab., Tenn.). J. Radioanal. Chem.; 11: No. 2, 265-71(Aug 1972).

An evaluation of the sensitivity of mercury and cadmium determinations in large volumes of water is presented. A 10-μg ^{252}Cf source immersed in the water sample served as a neutron source. The (n,γ) reaction on hydrogen and the inelastic scattering from oxygen produced a background count rate that limited sensitivity. A lower limit of 20 ppM for both mercury and cadmium was found. The procedures described here can be applied to most of the other heavy metals. (auth)

29 SIMULTANEOUS DETERMINATION OF LEAD, COPPER, AND ZINC IN MULTIMETAL ORES AND THEIR PROCESSED PRODUCTS BY ACTIVATION ANALYSIS. Navalikhin, L. V.; Kireev, V. A.; Talanin, Yu. N.; Nikonorov, G. S. (Atomic Energy Commission, Moscow). J. Radioanal. Chem.; 11: No. 2, 257-64 (Aug 1972).

A method is proposed for the simultaneous determination of lead, copper, and zinc in multimetal ores and their products by cyclic irradiation and measurement. The relative standard deviation is 10 to 20%, the total time required for the analysis of one sample is 10 min. (auth)

30 ACTIVATION ANALYSIS BASED ON CHARACTERISTIC AND SOFT GAMMA RADIATION USING DIFFERENTIAL FILTERS. Zaitsev, E. I. (Inst. of Mineralogy, Geochemistry, and Crystallochemistry of Rare Elements, Moscow). J. Radioanal. Chem.; 11: No. 2, 241-55(Aug 1972).

The potentialities of activation analysis based on characteristic and soft γ radiation are discussed for the case of long-lived isotopes produced by irradiation with thermal neutrons. The proposed method is investigated by analyzing natural rock and mineral samples with known contents of elements. (auth)

31 METHOD FOR THE DETERMINATION OF ADDITIVE ELEMENTS IN SINTERED TUNGSTEN METAL RODS BY FAST NEUTRON ACTIVATION ANALYSIS. Nagy, A. Z. (Central Research Inst. for Physics, Budapest); Csoke, A.; Pocs, L.; (and others). J. Radioanal. Chem.; 11: No. 2, 231-40(Aug 1972).

A nondestructive activation analytical method developed for the determination of the axial concentration distributions of Al, Si, and K residual additives in sintered tungsten rods is briefly described. A 14-MeV neutron generator is used to produce the reactions $^{27}Al(n,p)^{27}Mg$, $^{28}Si(n,p)^{28}Al$, and $^{39}K(n,2n)^{38}K$ and the activities are compared with standards. A weighted least-squares fitting program is used for peak area determination of the scintillation spectra. A scheme of the irradiating and measuring arrangement with a pneumatic sample-transfer system is presented. The system is applicable to large-scale routine analysis and lends itself well to automation. The results of preliminary measurements with this arrangement are given. (auth)

32 USE OF DISPLACEMENT EXTRACTION CHROMATOGRAPHY IN ACTIVATION ANALYSIS. Alimarin, I. P.; Yakovlev, Yu. V.; Stepanets, O. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). J. Radioanal. Chem.; 11: No. 2, 209-19(Aug 1972).

A method of element separation was worked out with the use of substoichiometric exchange reactions in combination with extraction chromatography. The principle of the method consists in the successive displacement of elements with lower extraction constants from their complexes by a substoichiometric amount of an aqueous solution of a competitive metal with a higher extraction constant. As stationary phase a chloroform solution of zinc diethyldithiocarbamate was used in the column, and a porous polytetrafluoroethylene (Ftoroplast PF-4) was employed as an inert supporting material. The method was used for the radioactivation determination of zinc, copper, cadmium, silver, mercury, manganese, cobalt, and iron traces in yttrium, molybdenum, zirconium, niobium, and beryllium. When samples weighing 0.1 to 1 g were irradiated for 20 hrs with a neutron flux of $1.2 \cdot 10^{13}$ n $\cdot$ $cm^{-2} \cdot sec^{-1}$, the determination sensitivity was 10^{-4} to 10^{-8}%. (auth)

33 SIMPLE METHOD FOR THE ACTIVATION ANALYSIS OF MERCURY IN FISH BY USING IODINATED RESINS. Montoloy, F.; Heurtebise, M.; Lubkowitz, J. (Instituto Venezolano de Investigaciones, Cientificas, Caracas). J. Radioanal. Chem.; 11: No. 2, 167-73(Aug 1972).

After irradiation and decay periods, samples are dissolved in 20 min in a sulfuric acid–nitric acid mixture containing a metavanadate salt. The aqueous phase is neutralized and passed through an iodinated resin, which selectively isolates mercury from all other interfering radionuclides. The activity of ^{197}Hg is determined by γ spectrometry using a thin NaI(Tl) detector. A sensitivity limit of 2.5 ppB was obtained and the relative standard deviation of the method is 6.7% at a level of 85 ppB. (auth)

34 SYMPOSIUM OM TUNGMETALLFORURENSNINGER. (Symposium on Heavy Metal Pollution). Conference Held at Hurdal, Norway, February 14, 1972. Oslo; Norges Teknisk-Naturvitenskapelige Forskningsraad (1972). 218p. (CONF-720215).

Twenty four papers presented are included. A separate abstract was prepared for one paper. (M.C.G.)

For an abstract of an individual paper see: 35.

35 ACTIVATION ANALYSIS. Lunde, G. (Sentralinstitutt for Industriell Forskning, Oslo). pp 23-9 of Symposium om Tungmetallforurensninger. Oslo; Norges Teknisk-Naturvitenskapelige Forskningsraad (1972). (In Norwegian).

From Symposium on heavy metal pollution; Hurdal, Norway (14 Feb 1972). See CONF-720215.

The background and scope of activation analysis work in Norway are briefly surveyed. The general principles and theory of activation analysis are outlined and registration techniques summarized. Accuracy, precision, and sensitivity are defined. The main characteristics of activation analysis are described and examples of the applications, especially in environmental pollution studies, are given. (Norway)

36 SPECTRAL ANALYSIS OF PURE PREPARATIONS OF ZIRCONIUM AND HAFNIUM. Zakhariya, N. F.; Pshetakovskaya, N. A. (Inst. of General and Inorganic Chemistry, Odessa). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 208-11(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 169-72(Feb 1972).

Methods were developed for determining impurities in hafnium and zirconium. Combustion of the sample and fractional distillation of impurities were both used. The rapid distillation method was also used to analyze ZrO_2 and HfO_2 for impurities. Sensitivities for determination of Sb, Al, Si, Cu, Be, Mg, Ca, Cd, B, Ga, In, Sn, Pb, Ti, Bi, V, Nb, Ta, Cr, Mo, Mn, Fe, Ni, and Co are given. (M.C.G.)

37 ANALYSIS OF SELENIUM BY PROTON BOMBARDMENT. Bodart, F.; Deconninck, G. (Facultes Universitaires, Namur, Belg.). Int. J. Nondestruct. Test.; 4: No. 2, 171-81 (Sep 1972).

A method of quantitative analysis of selenium in organic and inorganic compounds is described. It consists of bombarding a solid sample with protons and detecting atomic x rays or nuclear γ rays with semiconductor detectors. No special preparation is necessary and the analysis is extremely rapid in the case of x-ray detection. A comparison is made of the two methods described and the respective sensitivities are estimated. Quantitative measurements of concentrations as low as 1000 ppM are possible on organic compounds. Qualitative detection of concentrations as low as 50 ppM is still possible. The amount of substance necessary for such an analysis is of the order of 100 mg. (auth)

38 SELENIUM DETERMINATION IN HUMAN SERUM LIPOPROTEIN FRACTIONS BY NEUTRON ACTIVATION ANALYSIS. Morss, S. G.; Ralston, H. R.; Olcott, H. S. (Univ. of California, Berkeley). Anal. Biochem.; 49: No. 2, 598-601(Oct 1972).

The absolute amount of selenium in human serum lipoproteins was determined by a neutron activation method developed to measure micro quantities of selenium in the presence of the high salt concentrations used in the ultracentrifugal preparation of serum lipoprotein fractions. By this technique the average selenium content of the sera from 11 young adults was 129 ± 34 mg Se/ml; less than 6% of this selenium was present in the lipoprotein fractions. (auth)

39 INTERNAL STANDARD METHOD FOR DETERMINATION OF SILICON IN YTTRIUM OXIDE BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Alstad, J.; Danielssen, T. (Univ. of Oslo). Radiochem. Radioanal. Lett.; 11: No. 6, 379-87(20 Oct 1972).

A simple method is described for determining silicon in high-purity yttrium oxide, whereby yttrium is used as an internal standard in activation analysis with 14-MeV neutrons. The detection limit is 10 ppM SiO_2. Interferences of phosphorus, aluminum, and iron have to be particularly taken into consideration. Thus phosphorus is determined independently by thermal neutron activation analysis. Using $^{63}Cu/n,2n/^{62}Cu/\sigma$ = (511 ± 15) mb/ as the monitor, reaction cross sections for $^{28}Si(n,p)^{28}Al$ and $^{89}Y(n,2n)^{88}Y$ were found to be (218 ± 10) mb and (663 ± 46) mb, respectively. The method was applied on a series of samples of yttrium oxide from various suppliers. (auth)

40 EXTRACTION OF THALLIUM WITH THIONALIDE AND ITS APPLICATION TO THE DETERMINATION OF THALLIUM IN ROCKS BY SUBSTOICHIOMETRIC NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 11: No. 6, 367-78(20 Oct 1972).

A new extraction system was studied for the extraction of thallium(I) into chloroform as its thionalide complex. The extraction of Tl(I) was quantitative from 1 to 2N NaOH solutions and selective in the presence of Na_2EDTA and KCN. A substoichiometric extraction method based on this system is used for the determination of trace amounts of thallium in standard rocks such as W-1, PCC-1, and Sye-1, and a meteorite Allende de Publito. (auth)

41 EXTRACTION CHROMATOGRAPHY USING CHELATING AGENTS. IV. SEPARATION OF Re(VII) AND Tc(VII), AND ITS APPLICATION IN ACTIVATION ANALYSIS. Sebesta, F. (Technical Univ., Prague); Posta, S.; Randa, Z. Radiochem. Radioanal. Lett.; 11: No. 6, 359-65(20 Oct 1972).

A method for the separation of $^{186+188}Re$ and ^{99m}Tc using extraction chromatography, with N-benzoyl-N-phenylhydroxylamine in chloroform is described. The method was applied for the determination of traces of rhenium in molybdenite by destructive neutron activation analysis. (auth)

42 DETERMINATION OF NANOGRAM QUANTITIES OF LEAD BY PHOTON ACTIVATION ANALYSIS. Chattopadhyay, A.; Jervis, R. E. (Univ. of Toronto). Radiochem. Radioanal. Lett.; 11: No. 6, 331-41(20 Oct 1972).

A method for determination of nanogram quantities of lead by photon activation analysis was developed. The method consists of irradiating environmental samples in a high-flux, 35-MeV bremsstrahlung beam and determining the lead content instrumentally with a Ge(Li) detector using the 0.899- and 0.911-MeV γ rays of 67-m ^{204m}Pb. Samples containing low levels of lead (viz. less than 1 to 5 ppM) required chemical separation after activation and counting with a NaI(Tl) detector for the 0.279-MeV γ ray of 52.1-h ^{203}Pb. The method was applied to determine the lead content of muck soils from a marsh gardening tract, which were found to contain from 7 to 22 ppM. (auth)

43 METHOD FOR THE NEUTRON ACTIVATION ANALYSIS OF NATURAL WATERS FOR ARSENIC. Ray, Barbara J.; Johnson, David L. (Univ. of Rhode Island, Kingston). Anal. Chim. Acta; 62: No. 1, 196-9(Nov 1972).

The co-crystallization of arsenic with thionalide (α-mercapto-N-2-naphthylacetamide) in low pH aqueous media was used to concentrate arsenic prior to activation with thermal neutrons. Arsenic-76 activity is determined by γ-ray spectroscopy methods and calibration is accomplished by standard addition. The technique is applicable to a variety of fresh and salt waters. (D.H.M.)

44 NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. VI. DETERMINATION OF ANTIMONY. Gijbels, R.; Dams, R. (Ghent Univ.). Anal. Chim. Acta; 62: No. 1, 191-5(Nov 1972).

A method for neutron activation analysis of high-purity selenium is presented in which the selenium activity was removed by reductions with hydroxyammonium chloride and the arsenic activity by distillation, after which antimony was precipitated as the sulfide, and counted with a Ge(Li) detector. High-resolution γ-spectrometry was necessary in order to discriminate against photopeaks from the natural background and from ^{76}As and ^{74}As activities. The chemical yield was determined by titration with bromate, after dissolution of the sulfide in sulfuric acid. (D.H.M.)

45 DETERMINATION OF RHENIUM IN FLUE DUST BY NEUTRON ACTIVATION ANALYSIS. Govaerts, A.; Gijbels, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta; 62: No. 1, 79-85 (Nov 1972).

Rhenium was determined by radiochemical neutron activation analysis in flue dust samples of complex chemical composition. Two separation techniques were used: distillation from perchloric–hydrochloric acid solution and hydroxide scavenging followed by extraction with tetraphenylarsonium chloride in chloroform. ^{186}Re and ^{188}Re were measured with a Ge(Li) low-energy photon detector. Chemical yields were determined by reactivation. For a neutron flux of 5×10^{11} n cm^{-2} s^{-1}, an irradiation time of 6 h and samples of ca. 1 g, down to 50 ppB of rhenium could be determined. (auth)

46 INVESTIGATION OF THE AEROSOL CONTENT OF GREENLAND SNOW BETWEEN 1880 AND 1968. Federer, B. (Swiss Inst. for Snow and Avalanche Research, Davos). pp 280-7 of Supplement Volume of the Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1971).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990-(Suppl.).

Results are reported on measurements of the Na, Cl, and SO_4 concentrations as a function of time in snow from Jarl Joset in Greenland. There was no detectable increase in the sulfate concentration between 1880 and 1968. The sulfate to chloride ratio in polar snow is at least 20 times higher than in seawater. The concentrations of sulfate and sea salt are parallel in time over the period 1880 to 1968. It is concluded that industrial sulfur cannot reach the polar atmosphere, the excess sulfate is probably a consequence of a fractionation process, and a marine origin of the sulfate is indicated. Neutron activation without chemical separation was used for the analyses. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 101, 194, 212, 722, and 819.

47 (CEA-N-1541) MASS SPECTROMETER FOR ISOTOPIC ANALYSIS OF THE OXYGEN OF WATER. Majoube, Michel; Nief, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1972. 18p. (In French). Dep. NTIS (U. S. Sales Only).

A mass spectrometer for directly measuring the isotopic oxygen ratio $^{18}O/^{16}O$ of water is presented. Liquid water is injected into the apparatus and vaporizes at the gas line. The $H_2{}^{16}O^+$ and $H_2{}^{18}O^+$ lines were measured. The memory effect (water introduced into the apparatus, which is not entirely eliminated when changing samples) and the corrosion of the ion source were studied. The memory effect is almost completely suppressed if two capillaries are led directly into the ion source and the apparatus maintained at about 150°C. Corrosion is avoided by using only Cu to construct the elements of the ion chamber. Only the electron emitting filament is made of tungsten or rhenium. For normal concentrations, the following results were obtained: quantity of H_2O necessary for the analysis = 10 mg; duration of analysis = 20 mn; mean square deviation = 0.08. (France)

48 (CEA-R-4348) DETERMINATION OF TRACE ELEMENTS IN URANIUM USING SPARK MASS SPECTROMETRY. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1972. 17p. (In French). Dep. NTIS (U. S. Sales Only).

Use of the CETAMA method for the determination of impurities in U using mass spectrometry requires an interlaboratory comparison of the results obtained with a particular sample. This verification is used to demonstrate the validity of the method. Quantitative values of the impurity contents can be determined after a statistical treatment of the elementary results. This statistical treatment confirms the existence of theoretical correction factors. It also demonstrates the usefulness of spark mass spectrometry in revealing microscopic homogeneity defects. (France)

49 (FRNC-TH-215) QUANTITATIVE ANALYSIS OF URANIUM BASED CERAMICS USING X-RAY DIFFRACTION TECHNIQUES. Conti, Robert (Paris Univ., Orsay (France). Faculte des Sciences). 1969. 76p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The optimum conditions for preparing various uranium-based ceramics (UO_2, U_3O_8, UC, and UC_2) were studied. The accuracy and sensitivity of the different x-ray diffraction techniques used for determining these compounds in mixtures are compared. Comparative determinations were used to analyze binary mixtures $UO_2-U_3O_8$, $UC-UC_2$, UO_2-UC, and UC_2-C. The Debye–Scherrer method is indispensable when only small quantities of sample material are available. The internal standard method was applied to the quantitative analysis of the ternary mixture of UO_2-UC-U (with ThO_2 as the internal standard). The standard addition method was used to determine UC in UC_2 and UC_2 in C (graphite). (France)

50 (K-L-6302) SPECIAL PROCESS ANALYZERS AT THE ORGDP. Pappas, W. S.; Weber, C. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 12 Sep 1972. Contract W-7405-eng-26. 35p. (CONF-721025-7). Dep. NTIS.

From sixteenth conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

The design principles and a few applications of some process analyzers developed for application to particular problems where commercially available equipment was not adequate are described. Moisture, UF_6, fluorine, and trace fluoride in air are determined. Diagrams and pictures of the equipment are included. (M.C.G.)

51 (K-L-6303) INSTRUMENTATION AND TECHNIQUES FOR CORROSIVE GAS CHROMATOGRAPHY. Million, J. G.; Pappas, W. S.; Weber, C. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 14 Sep 1972. Contract W-7405-eng-26. 20p. (CONF-721025-5). Dep. NTIS.

From sixteenth conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

Analysis of complex mixtures of corrosive halogen and halide gases using gas chromatography is considered. Instrument design, columns, and applications are described. Pictures are included. (M.C.G.)

52 (K-L-6304) EMISSION SPECTROGRAPHIC MEASUREMENT OF 62 IMPURITY METALS IN URANIUM COMPOUNDS. Farrar, R. B. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 29 Sep 1972. Contract W-7405-eng-26. 23p. (CONF-721025-2). Dep. NTIS.

From sixteenth conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

Two general approaches are used. In one, the impurities are chemically separated from uranium and concentrated prior to the spectrographic analysis to minimize interferences and improve analytical sensitivity. In the other approach, the carrier distillation technique provides the separation of the impurities from the uranium in the sample electrode during the arc excitation of U_3O_8, yielding a favorable impurity spectrum over the uranium background. Thirty-four elements are determinable by carrier distillation techniques and thirty-one elements are measured after chemical separation. Several metallic elements can be measured by both approaches. (M.C.G.)

53 (Y-1849) DETERMINATION OF LOW CONCENTRATIONS OF URANIUM IN OILS AND ORGANIC LIQUIDS BY X-RAY EMISSION. Adams, T. T.; Barton, T. H. Jr.; Ferguson, M. R. (Oak Ridge Y-12 Plant, Tenn. (USA)). 17 Oct 1972. Contract W-7405-eng-26. 13p. Dep. NTIS.

An improved method was developed for determining the concentration of uranium in organic liquids by x-ray emission. The method is applicable to uranium concentrations in the range of 10 to 2,000 micrograms per milliliter. (auth)

54 (Y-DK-85) HIGH RESOLUTION AND PULSED NMR SPECTROSCOPY. Rutenberg, A. C.; Dorsey, J. G. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 18 Sep 1972. Contract W-7405-eng-26. 11p. (CONF-721025-6). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

Equipment and capabilities of the Nuclear Magnetic Resonance Laboratory of the Oak Ridge Y-12 plant are described. Details are given on the Bruker high-resolution spectrometer with Fast Fourier Transform capability for signal-to-noise enhancement and a Bruker pulsed-wide line spectrometer system. Diverse applications of the equipment include the semiquantitative analysis by the spin counting technique, diffusion coefficient measurements utilizing a pulsed gradient, high resolution and pulsed studies related to adhesives, NMR studies of carbon precursors, and high resolution measurements on nuclei other than ^1H. (J.G.B.)

55 (Y-DK-86) SPARK SOURCE MASS SPECTROMETER USING ELECTRICAL DETECTION. Franklin, J. C.; Hicks, H. L.; Griffin, E. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 16 Oct 1972. Contract W-7405-eng-26. 13p. (CONF-721025-3). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

The electron multiplier that is used as detector embodies two complementary techniques: peak scanning and peak switching. Peak scanning employs an exponential magnet scan to sweep each peak of the spectrum across the ion detector, and the log ratio of the monitor and the collector signals is recorded on a uv recorder and/or a computer for on-line data processing. Peak switching employs cyclic scan and voltage switching by a decade control to switch several peaks in turn onto the collector. In this mode, a number of channels are provided so that the ion accelerating voltage can be switched to preset values at which the ion beams of the elements of interest are turned onto the exit slit and detected by the electron multiplier. A predetermined integration of the total ion signal is used as the measurement to which the detected impurity signal is ratioed; this ratio is recorded on a digital voltmeter, and for convenience the peaks may be viewed on an oscilloscope screen. Results are given on isotopic analyses of Pb and Zr samples. Results are also given for the determination of Cr, Cu, Co, Mn, Ni, and Zr in NBS-462 steel samples. (J.G.B.)

56 EXTRACTION-FLUOROMETRIC DETERMINATION OF TELLURIUM WITH ASYMMETRIC RHODAMINE DYES. Khvatkova, Z. M.; Golovina, A. P.; Zorov, N. B.; Belova, N. K.; Alimarin, I. P. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 355-7(1972). (In Russian).

Optimum conditions of formation and extraction of chloride and bromide complexes of Te(IV) with rhodamines 3 GO and 4 G were studied. The more sensitive reagent was rhodamine 4 G. The effects of gallium, indium, and cadmium on determination of tellurium were investigated. (auth)

57 SPECTROGRAPHIC ANALYSIS OF Na INTENDED FOR NUCLEAR APPLICATIONS. Ricard, J. (Ugine-Kuhlmann, Jarrie, France). Method. Phys. Anal.; 8: No. 1, 32-4(Mar 1972). (In French).

A spectrographic method for determining impurities in nuclear Na is suggested. The following impurities can be determined with an accuracy of between one and several hundred ppM: Ca, Ba, K, Li, Sr, Ag, Al, B, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Si, Sn, Ti, and V. The operating conditions are given. (France)

58 EMISSION SPECTROSCOPY. Snooks, E. C. pp 437-75 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Emission spectroscopy is discussed under the following section headings: optics and the spectrograph; detection; excitation; sample preparation; results; and detection limits—a comparison. Detection limits are given for 76 elements. (J.G.B.)

59 FLAME SPECTROPHOTOMETRIC TRACE ANALYSIS. Burrell, David C. (Univ. of Alaska, College). pp 477-534 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Practical application of flame emission, atomic absorption, and fluorescence to the determination of elements present in a sample matrix in trace quantities is discussed. Emphasis is forced on the basic principles underlying the various operations involved. Interference effects are discussed in a general fashion. Detection limits are given for 50 elements. (139 references) (J.G.B.)

60 PROCEEDINGS OF THE 2nd CONFERENCE ON APPLIED PHYSICAL CHEMISTRY, VESZPREM, HUNGARY, AUGUST 2-5, 1971. VOLUME 1. Buzas, I. (ed.). Budapest; Akademiai Kiado (1971). 759p. (CONF-710844-(Vol.1)).

Five papers have been abstracted individually for NSA. The remaining 91 papers deal with various aspects and uses of instrumental techniques of analysis, including spectrophotometry, fluorometry, gas chromatography, thin-layer chromatography, derivatography, refractometry, and colorimetry. (J.G.B.)

For abstracts of individual papers see: 15, 61, 81, 139, and 194.

61 PHOTOMETRIC DETERMINATION OF ZIRCONIUM AND COPPER BY MEANS OF AZO DYES. Pachadzanov, D. N.; Yusupov, M. Yu. (Inst. of Chemistry, Dushanbe, USSR). pp 345-7 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844-(Vol.1).

Two azo dyes were synthesized, 4-phenylthiazolyl(2-azo-2)-1, 8-dihydroxynaphthalene-3,6-disulfonic acid (I), for the spectrophotometric determination of Zr, and 3-carboxytriazolyl-(5-azo-2)-1,8-dihydroxynaphthalene-3,6-disulfonic acid (II), for the colorimetric determination of Cu. The effects of U(VI), Zn, Co, Ni, Ca, Mg, Ba, Cu, Al, Ga, Mo, and chloride, sulfate, silicate, and phosphate ions on the determination of Zr were studied. The method is simple, precise, and sensitive. Error for the determination of Cu was 0.14%. (J.G.B.)

62 SOLOCHROME AZURINE BS AS AN INDICATOR FOR THE EDTA TITRATION OF THORIUM(IV). Sharma, Chokhe Lal (Univ. of Roorkee, India). Indian J. Chem.; 9: No. 5, 499(May 1971).

Solochrome azurine BS is found to be a satisfactory indicator for the complexometric titration of Th(IV), even at a concentration of 0.00025M in the pH range 3.5 to 5.5. A number of foreign ions including Al^{3+} and Sb^{3+} do not interfere even if present in excess, while traces of Ce^{4+}, Cu^{2+}, Ca^{2+}, F^-, PO_4^{3-}, etc., interfere in the determination of thorium(IV). (auth)

63 N-BIS(β-AMINOETHYL)-DITHIOCARBAMIC ACID, A NEW COLORIMETRIC REAGENT FOR MOLYBDENUM. Deshmukh, G. S.; Chattopadhyay, S. S. (Banaras Hindu Univ., India). Indian J. Chem.; 9: No. 5, 498-9(May 1971).

Use of N-bis(β-aminoethyl)-dithiocarbamic acid as a specific reagent for the colorimetric estimation of Mo(VI) is described. Beer's law is obeyed in the concentration range 0.15 to 0.6 mg Mo^{6+}/20 ml. A large number of anions, viz. halides, nitrate, sulfate, tartarate, oxalate, citrate, phosphate, borate, cyanide, and carbonate, do not interfere. The interference due to Se^{4+}, Te^{4+}, Ce^{4+}, V^{5+}, Cu^{2+}, Fe^{3+}, Ni^{2+}, and Co^{2+} was removed by the use of masking reagents. (auth)

64 OXYGEN AND CARBON ISOTOPE COMPOSITION OF CHICKEN EGG SHELL CARBONATE. Sharma, T.; Pillai, N. V. (Indian Inst. of Tech., Kanpur). Indian J. Chem.; 9: No. 5, 456-8 (May 1971).

$^{18}O/^{16}O$ and $^{13}C/^{12}C$ ratios were determined in chicken egg shell carbonate. The $\delta^{18}O$ values of the egg shells are of the same order while the $\delta^{13}C$ values are lower relative to the isotopic data for natural sedimentary carbonates and calcareons shells produced by marine organisms. Using the fractionation factors for $CO_2-HCO_3^-$ and $HCO_3^--CO_3^-$ equilibria, the $\delta^{13}C$ values of the source bicarbonate and carbon dioxide were determined. The $\delta^{18}O$ and $\delta^{13}C$ variations among the samples may be due to variations in the isotopic composition of the source carbon dioxide and water. (auth)

65 METHOD AND APPARATUS FOR DETERMINING HYDROGEN CONCENTRATION IN LIQUID SODIUM UTILIZING AN ION PUMP TO IONIZE THE HYDROGEN. Vissers, Donald R.; Holmes, John T.; Nelson, Paul A.; Barthoime, Louis G. (to United States Atomic Energy Commission). U. S. Patent 3,683,272. 8 Aug 1972. Filed 24 Nov 1970.

A device for and method of measuring hydrogen concentration in liquid sodium to detect water leaks into the sodium is described. A thin-wall, tubular, annealed nickel probe in contact with liquid sodium is connected to an ion pump. A vacuum is created within the nickel probe by the ion pump, causing hydrogen atoms in the liquid sodium to diffuse through the wall of the probe and be drawn into the ion pump wherein the hydrogen atoms are ionized. The current generated within the ion pump by the ionization of hydrogen atoms is measured, this current being indicative of the hydrogen concentration in the liquid sodium. (Official Gazette)

66 MASS SPECTRAL ANALYSIS OF THE ISOTOPE COMPOSITION OF ELEMENTAL BORON BY MEANS OF ITS FLUORINATION DIRECTLY IN THE ION SOURCE. Lyubimov, V. N.; Semyannikov, P. P.; Grankin, V. M.; Koval'chuk, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk; No. 2, 84-8(Mar 1972). (In Russian).

The isotope analysis of elemental boron was carried out by means of its fluorination directly in the Knudsen cell inside the ion source of the mass spectrometer. The B + PbF_2 mixture with 1:50 weight ratio is heated to 350°C and the ^{11}B : ^{10}B isotope ratio measured with the aid of B^+ ion peaks. The "memory effect" disappears completely during 4 hours of heating the Knudsen cell

and much earlier if it has been previously heated in vacuum. One mg of boron is sufficient quantity for recording the mass spectrum during the more than 5 hours of continuous monitoring. (auth)

67 BARIUM AT GEOSECS III IN THE SOUTHWEST PACIFIC. Bacon, M. P.; Edmond, J. M. (Massachusetts Inst. of Tech., Cambridge). Earth Planet. Sci. Lett.; 16: No. 1, 66-74 (Sep 1972).

A detailed, highly precise barium profile was measured at Geosecs III, off Tonga, in the southwest Pacific. There is a smooth increase from the surface values of 4.7 μg/kg to a deep maximum of 18.4 μg/kg at 2.974 km. Below this maximum there is an abrupt decrease to 14.3 μg/kg in the deep Western Boundary Current. Comparison with published data shows recent Pacific and Antarctic barium profiles to be consistent within 2%. Model calculations do not require any in situ injection of barium (or of silicate or alkalinity) in the water column; the form of the profile can be explained by vertical diffusion and advection between horizontally advecting water masses. From the θ-S curve it appears that a minor core of higher salinity water, possibly derived from Ross Sea bottom water, or the North Atlantic deep water core in the Circumpolar Current, is present immediately above the deep Boundary Current. Isotope dilution and mass spectrometry were used to determine the barium content. (auth)

68 CHEMICAL-SPECTROSCOPIC METHOD FOR THE DETERMINATION OF SCANDIUM IN BAUXITES USING THREE-PHASE EXTRACTION SYSTEMS. Zhivopistsev, V. P.; Makhnev, Yu. A.; Kalmykova, I. S. (Perm State Univ., USSR). Ind. Lab. (USSR) (Engl. Transl.); 38: No. 2, 173-4(Feb 1972).

Translated from Zavod. Lab.; 38: No. 2, 145-6(Feb 1972).

During extraction with diantipyrylmethane in a mixture of chloroform and benzene the organic layer separates into two phases. The scandium concentrates almost completely in one of these phases, the so-called third phase, whose volume is no more than a few drops. This viscous phase is deposited on the electrodes and analyzed spectrographically. Modification of the method so that scandium is first extracted in chloroform, benzene is added to the separated chloroform extract, and the third phase forms, makes it possible to extract scandium in the presence of a silicic acid precipitate. The sensitivity of the method is 1 to 3 μg of scandium and the relative error does not exceed 10%. (M.C.G.)

69 CHEMICAL AND ELECTROCHEMICAL REDUCTION OF RUTHENIUM(IV) IN HYDROCHLORIC ACID SOLUTIONS. Potts, Lawrence Walter. Minneapolis; Univ. of Minnesota (1972). 253p. University Microfilms Order No. 72-27,792.

Thesis.

A method for quantitative removal of iron from hydrochloric acid solutions of ruthenium(III) and (IV) is described. The chemical behavior of ruthenium(IV) and (III) in chloride solutions and the physical properties of the synthesized Ru(IV) salts are discussed. A titrimetric method for the determination of ruthenium in hydrochloric acid (3 to 30 mg Ru in 200 ml) is proposed. This method is both accurate and precise, as well as convenient for the analysis of ruthenium distillates. The electrochemical reduction of dimeric ruthenium(IV) to ruthenium(III) in hydrochloric acid solutions follows a second-order ece mechanism. The results of the chronopotentiometric, steady-state voltammetric (rotating platinum disk), and linear scan voltammetric reduction of dimeric ruthenium(IV) in supporting electrolytes of 6N HCl and less are consistent with an irreversible one-electron per linear process ($E_{\frac{1}{4}}$ = +0.49 ± 0.01 volt vs. NHE in 2N HCl). In 9N HCl the results obtained using these techniques are consistent with an ece process, showing both one- and two-electron per dimer characteristics over the experimental time scales. Constant potential coulometry established that the overall reduction process involves two-electrons per dimer. Plots of log i/i_0 vs. t have shapes characteristic of an ece process. The reduction mechanism is unaffected by allowing solutions of Ru(IV) dimer to equilibrate in 2N HCl. The identity of electrochemically generated Ru(III) and chemically generated Ru(III) (reduction of Ru(IV) dimer by mercury) is established spectrally. Results of cyclic voltammetry studies of the reduction of dimeric Ru(IV) showed that the one-electron per dimer reduction product is reoxidized to a species of Ru(IV) dimer, which is different than the original dimer species. The potentials at which the reoxidized Ru(IV) species is reduced indicates that it is similar to species obtained by allowing a solution of Ru(IV) dimer to equilibrate ("age") in 2N HCl. It is proposed that a rapid ligant exchange occurs during the reduction of dimeric Ru(IV). The standard potential of the Ru(IV) monomer/Ru(III) monomer couple in 9N HCl is +0.985 volt vs. NHE using cyclic voltammetry. The rate of the chemical step is measured at a thin-ring, thin-gap rotating ring-disk electrode in supporting electrolytes of 7.98, 8.51, and 8.95 N HCl. The data are treated using a computerized digital simulation model, and the results are consistent with the rate law, rate = k[Dimeric Ru(IV)][HCl]. (Diss. Abstr. Int., B)

70 TRACE-METAL ANALYSIS USING ATOMIC ABSORPTION SPECTROPHOTOMETRY. Egan, John T. (Water Quality Control, New York); Peterson, George E. J. Amer. Water Works Ass.; 64: No. 10, 669-73(Oct 1972).

The methods used in the water-quality-control laboratories of New York City are described. Samples are received for analysis daily from system reservoirs and once a week from supply streams. All samples for atomic absorption analysis are membrane-filtered and acidified with nitric acid. Ag, Zn, Cr, Sr, Cd, Pb, Cu, and other metals were determined. (M.C.G.)

71 METHOD OF PRECISION EXPRESS-ANALYSIS OF HYDROGEN ISOTOPE CONTENT IN NATURAL WATERS. Vetshtein, V. Yu.; Miroshnichenko, A. G.; Artemchuk, V. G. (Inst. of Physical Chemistry, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 7, 632-4(Jul 1972). (In Ukrainian).

The thermochemical method of hydrogen isolation from natural waters is described for precision mass spectrometric analysis of its isotopic content with an accuracy of ±0.5% of the value D/H. (auth)

72 ANALYTICAL APPLICATIONS OF THIO-, SELENO-, AND TELLUROETHERS. II. SPECTROPHOTOMETRIC DETERMINATION OF PALLADIUM WITH THIOETHERS. Pitombo, Luiz R. M. (Univ., Sao Paulo, Brazil). Anal. Chim. Acta; 62: No. 1, 103-12(Nov 1972).

Palladium is very efficiently extracted with benzene solutions of thio-, seleno-, and telluroethers from acidic solutions. Methods based on symmetrical and asymmetrical thioethers are presented. Benzene solutions of 16 thioethers can be used to determine palladium spectrophotometrically in the range 1.25 to 4.40 ppM in the measured extracts. Separation of palladium from platinum metals, as well as many other metal ions and anions, is reported. (auth)

73 KINETIC–CATALYTIC CONTINUOUS ANALYSIS METHOD USING A FLOW-THROUGH CELL. DETERMINATION OF IODIDE, MERCURY, MANGANESE, AND LEAD. Weisz, H.; Ludwig, H. (Univ., Freiburg i. B.). Anal. Chim. Acta; 62: No. 1, 125-35(Nov 1972). (In German).

A continuous kinetic–catalytic method of analysis is described. The reactants involved in a catalytic reaction and the catalyst to be determined flow continuously in three separate streams to a flow-through cell and are mixed there. In this system, a "stationary" condition is produced. In each case the "stationary" concentration of a suitable reactant is measured spectrophotometrically, which yields a measure of the catalytically active substance. Iodide can be determined continuously in the ppB to ppM range by means of its catalytic action on the cerium(IV) – arsenic(III) reaction. Mercury(II) prevents this catalytic action and so can be determined indirectly. Manganese can be determined in the ppB range by means of its catalytic action on the oxidation of alizarin S by hydrogen peroxide. Lead displaces manganese from its catalytically inactive complex with DCyTa and so can be determined continuously in the ppB to ppM range. (auth)

74 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM IN NICKEL-BASE ALLOYS WITH ARSENAZO III AFTER THENOYLTRIFLUOROACETONE EXTRACTION. Sekine, Keiichi; Onishi, Hiroshi (Japan Atomic Energy Inst., Tokai). Anal. Chim. Acta; 62: No. 1, 204-6(Nov 1972).

A spectrophotometric method for determining 0.01 to 0.1% zirconium in nickel-base alloys is presented that involves extraction with TTA before determination with arsenazo III. Six analyses of NBS 1203 sample gave a relative standard deviation of 1.3%. The hafnium that may be presented with zirconium was not considered. (D.H.M.)

75 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN SELECTIVE ORGANIC EXTRACTANTS WITH 2-(5-BROMO-2-PYRIDYLAZO)-5-DIETHYLAMINOPHENOL. Pakalns, P.; McAllister, Blanka R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Anal. Chim. Acta; 62: No. 1, 207-9(Nov 1972).

A spectrophotometric method for determining uranium in the organic phase using 2-(5-bromo-2-pyridylazo)-5-diethylaminophenol (bromo-PADAP) is presented that utilizes the formation of a single phase of water, kerosene, ethanol, and TBP or Alamine-336 with dimethylformamide. (D.H.M.)

76 EXTRACTION-SPECTROPHOTOMETRIC DETERMINATION OF OSMIUM WITH BISMUTHIOL-II IN PRESENCE OF MOST OF THE PLATINUM METALS AND OTHER IONS. Majumdar, A. K.; Bhowal, S. K. (Jadavpur Univ., Calcutta). Anal. Chim. Acta; 62: No. 1, 223-6(Nov 1972).

An extraction–spectrophotometric method using Bismuthiol-II is described by which as little as 6 ppM of osmium can be separated and determined from the following ions: Ir^{4+}, Pt^{4+}, Ru^{3+}, Rh^{3+}, Ni^{2+}, Co^{2+}, Fe^{3+}, Cr^{3+}, Mn^{2+}, As^{5+}, La^{3+}, Mg^{2+}, Sr^{2+}, Ba^{2+}, Al^{3+}, Ca^{2+}, Th^{4+}, rare earths, citrate, oxalate, tartrate, phosphate, EDTA, and fluoride. (D.H.M.)

77 SELECTRODE™: THE UNIVERSAL ION-SELECTIVE ELECTRODE. PART III. CONCEPT, CONSTRUCTIONS AND MATERIALS. Ruzicka, J.; Lamm, C. G.; Tjell, J. Chr. (Technical Univ. of Denmark, Lyngby). Anal. Chim. Acta; 62: No. 1, 15-28(Nov 1972).

The concept and construction of a multipurpose electrode, the selectivity of which can easily be changed, is described. The change of electrode response is achieved by using various electroactive materials, which can be either solid (solid-state selectrode) or liquid (liquid-state selectrode). A number of electroactive materials are discussed and sensitivities and characteristic potentials of various selectrodes are given. A reference electrode which employs a humidified solid salt instead of the saturated solution of an electrolyte is also described. (auth)

78 REACTION OF 2-MERCAPTOBENZIMIDAZOLE WITH TELLURIUM AND DETERMINATION OF TRACE AMOUNTS OF TELLURIUM. Ramanauskas, E.; Grodnikas, S. Liet. TSR Aukst. Mokyklu Mokslo Darb., Chem. Chem. Technol.; No. 12, 33-40(1970). (In Russian).

Te forms an intensely colored yellow complex with 2-mercaptobenzimidazole (I) in acid medium. The Te/I ratio in the complex is 1 : 2, the instability constant is 5.6×10^{-5}, and the molar absorptivity of the complex at 320 mn is 3.1×10^4. Ag, Hg^{2+}, Ca, and Se^{4+} interfered strongly in the determination. The method is recommended for determination of Te in Se (after dissolution, Se^{4+} is reduced to elemental Se with $NH_2OH \cdot HCl$; Te^{4+} is not reducible in this case) and in Cu salts (Cu is removed by sorption on KTs-2 cation exchanger); error in determination of Te is ≤10%. (Selenium-Tellurium Abstr.)

Radiometric and Radiochemical Procedures

Refer also to abstracts 293, 375, 379, 380, 383–386, 391–394, and 1897.

79 (LBL–647) TRACE ELEMENT ANALYSIS WITH SEMICONDUCTOR DETECTOR X-RAY SPECTROMETERS. Giauque, R. D.; Goulding, F. S.; Jaklevic, J. M.; Pehl, R. H. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jul 1972. Contract W-7405-eng-48. 54p. (CONF-720936–1). Dep. NTIS.

From eleventh national meeting of the Society for Applied Spectroscopy; Dallas, TX. (10 Sep 1972).

A method of obtaining high sensitivity and precision in x-ray fluorescence analysis using semiconductor detector spectrometers is discussed. Monoenergetic exciting radiation is employed to generate characteristic x rays from trace elements in thin, uniform specimens. Corrections for absorption effects are determined; enhancement effects are omitted as they are negligible for many thin specimens. A single element thin-film standard is used to calibrate for the x-ray geometry, and theoretical cross sections and fluorescent yield data are employed to relate the x-ray yields for a wide range of elements to the thin-film standard. Various corrections that affect the accuracy of the method are discussed including the method for determining x-ray spectral background. Results obtained in the analyses of biological and geological specimens, and of air particulate filters are reported. Using a single excitation energy, the concentrations of more than fifteen trace elements may be simultaneously determined during a fifteen minute interval for concentrations of 1 ppM or less. This corresponds to less than 10 ng/cm² on air particulate filters. (auth)

80 OXIDE-THICKNESS DETERMINATION BY PROTON-INDUCED X-RAY FLUORESCENCE. Musket, R. G.; Bauer, W. (Sandia Labs., Livermore, Calif.). J. Appl. Phys.; 43: No. 11, 4786-92(Nov 1972).

A discussion of the principles of oxygen surface density and, hence, oxide-thickness determination by proton-induced x-ray fluorescence is followed by results of several applications of the technique. This technique is shown to be useful for oxide thicknesses between ten and a few thousand Å. In practice, monoenergetic proton beams with energies between 100 and 400 keV produced characteristic x rays of all elements near the surface of aluminum, erbium dideuteride, copper, and stainless-steel specimens; these x rays were detected with a high-resolution Si(Li) detector. The oxygen K_α x-ray yields (x rays/proton) for these specimens were calibrated using known oxygen surface densities and, hence, oxide thicknesses on aluminum. (auth)

81 MICROGRAM DETERMINATION OF IODIDE BY MEANS OF ISOTOPIC EXCHANGE REACTIONS AND BY ELECTROCHEMICAL ISOTOPIC DILUTION ANALYSIS. Beronius, P.; Gabrielsson, A.-B. (Univ. of Umea, Sweden). pp 123-9 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844– (Vol.1).

The determination of microgram amounts of iodide ion by isotopic exchange in a single phase system was studied. Acetone was used as the solvent for the methyl iodide–iodide ion exchange reaction. An alternative previously reported method for microgram iodide determination based on isotope dilution and electrochemical determination of specific activities was also investigated. (J.G.B.)

82 MICRO ASSAY OF ITP PYROPHOSPHOHYDROLASE BY LIQUID SCINTILLATION. Vanderheiden, B. S. (Eastern Pennsylvania Psychiatric Inst., Philadelphia). Anal. Biochem.; 49: No. 2, 459-66(Oct 1972).

A micro assay method for determination of ITP pyrophosphohydrolase is described. It is based on direct determination of radioactivity by liquid scintillation counting of paper strips, following incubation of ^{14}C-labeled substrate (ITP) with tissue preparations, and subsequent separation of the ^{14}C-labeled products by high-voltage paper electrophoresis. The method can be adapted for determination of activities of related enzymes using ^{14}C-labeled substrates and giving rise to ^{14}C-labeled products. (auth)

83 COMPLETE STEREOCHEMICAL DISTRIBUTION OF ^{14}C-ISOTOPE IN CITRATE. Kent, S. S. (Univ. of Chicago). Anal. Biochem.; 49: No. 2, 393-406(Oct 1972).

A method is described for total stereochemical degradation of citrate. The procedure permits determination of the isotope distribution of five individual carbon atoms and the combined isotope distribution of seven carbon-fragment combinations. The original citrate molecule is degraded enzymically and carbon fragments C-1,2 and C-3,4 reincorporated stereospecifically as acetate into citrate. The oxalacetate fragment of citrate is converted to and degraded as aspartate. The key application of the colorimetric assay for citrate as a degradative method permits total quantitative decarboxylation of citrate to three moles of CO_2 and one mole of pentabromoacetone, the specific activities of which may be determined independently. The principles outlined may be used for the determination of intramolecular distributions of ^{14}C in acetate or compounds enzymically or chemically convertible to acetate. (auth)

84 MEASUREMENT OF ^{131}I AND ^{125}I BY LIQUID SCINTILLATION COUNTING. Bransome, E. D. Jr.; Sharpe III, S. E. (Medical Coll. of Georgia, Augusta). Anal. Biochem.; 49: No. 2, 343-52(Oct 1972).

The procedures employed are suitable for instruments with logarithmic or pseudologarithmic amplification or for systems with linear amplification. When aqueous samples were made miscible with a toluene scintillation solution by means of Bio-Solv BBS-3, high ^{125}I and ^{131}I efficiencies were achieved over a considerable range of impurity quenching. The procedures outlined are for choosing the best instrument settings for single- and double-isotope counting. (M.C.G.)

85 STUDIES ON THE DANSYLATION REACTION BY THE USE OF ^{14}C-DANSYL CHLORIDE: APPLICATION TO ANALYSIS OF FREE AMINO ACIDS IN THE RAT OPTIC NERVE. Casola, L.; di Matteo, G. (International Inst. of Genetics and Biophysics, Naples). Anal. Biochem.; 49: No. 2, 416-29(Oct 1972).

Conditions are reported for labeling amino acids with ^{14}C-dansyl chloride. The technique was used for the quantitative estimation of some amino acids present in amounts of optic nerve tissue as small as 0.1 mg. The results are similar to those obtained with the amino acid autoanalyzer. Optic nerve segments can synthesize amino acids, when incubated in vitro with radioactive glucose. (auth)

86 RADIOISOTOPIC X-RAY ANALYSIS. II. THE DETERMINATION OF SILVER, TIN, AND ANTIMONY IN LEAD. de Neef, J.; Adams, F.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta; 62: No. 1, 71-7(Nov 1972).

A 90° symmetry arrangement for the determination of silver, tin and antimony in pure lead by means of an energy-dispersive x-ray fluorescence spectrometer with ^{241}Am as excitation source is described. Two correction methods for matrix absorption are used. (auth)

Separation Procedures

Refer also to abstracts 98, 99, 112, and 134.

87 (INP–803) CHROMATOGRAPHIC COLUMN EXTRACTION OF INORGANIC COMPOUNDS. Stronski, Ignacy (Institute of Nuclear Physics, Krakow (Poland)). May 1972. 44p. (In German). Dep. NTIS (U. S. Sales Only).

Theoretical principles of column distribution chromatography with reversed phases are given. As examples, various extraction systems, such as liquid organic phosphorus derivatives, high-molecular-weight amines, ketones, and chelate-forming compounds used in studies on distribution of salts of lanthanides, transplutonium elements, actinides, uranium and its fission products, and other elements, are described. (tr-auth)

88 (TID–26194) RAPID RARE EARTH SEPARATIONS WITH PRESSURIZED ION EXCHANGE CHROMATOGRAPHY. Campbell, D. O. (Oak Ridge National Lab., Tenn.). [nd]. 23p. Dep. NTIS.

Separations of rare earths and actinides, ion exchange, chromatography, and pressurized ion exchange techniques are discussed. In pressurized ion exchange, a column of very fine ion exchange particles is used. A fairly high pressure is thus required to force solutions through the column. The advantages of the fine particles are discussed. This method gives very good separations in under an hour for two elements and in under two hours for all rare earths. (M.C.G.)

89 2-MERCAPTOPYRIDINE-N-OXIDE AND POSSIBILITIES OF ITS APPLICATION FOR CONCENTRATING. Busev, A. I.; Byr'ko, V. M.; Hoang Kim Yen; Novikova, N. N. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 319-22(1972). (In Russian).

2-Mercaptopyridine-N-oxide in $CHCl_3$ was shown to interact with Cu (II), Tl (III), Ti (III, IV), Zr (IV), V (V), Bi (III), Cr (III), Mo (VI), Fe (II, III), Ni (II), Co (II), Rh (III), Pt (IV), Nb (V), Ta (V), Re (VII). The reagent can be used for the concentrating by extraction of the elements mentioned. The spectrochemical determination of V and Ti after extraction by this reagent in $CHCl_3$ was carried out. (auth)

90 APPLICATION OF THE Ha_5 DESIGN FOR THE INVESTIGATION OF Zr AND Hf EXTRACTION BY n-DECYL ALCOHOL. Smirnova, N. S.; Granovskii, Yu. V.; Komissarova, L. N.; Golikova, T. I.; Maksimova, E. P. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 292-5(1972). (In Russian).

Optimal conditions for the separation of Hf and Zr in extraction from hydrochloric acid solutions by decyl alcohol were determined using Ha_5 design. Plan Ha_5 is a statistical approach to designing the conditions of a chemical engineering experiment. Certain statistical parameters of the design are described. The regression equation of the second order was derived, which included separation factors, phase ratio, metal and acid concentrations. (auth)

91 SINGLE AND MULTICOMPONENT EQUILIBRIUM DATA FOR THE EXTRACTION OF $SmCl_3$, $NdCl_3$, AND $CeCl_3$ IN ACIDIC CHLORIDE SOLUTIONS WITH DI-(2-ETHYLHEXYL) PHOSPHORIC ACID. Ioannou, Tom K. (Union Carbide Corp., Sistersville, W. Va.); Smutz, Morton; Bautista, Renato G. Met. Trans.; 3: No. 10, 2639-48(Oct 1972).

The extraction equilibria of the lanthanide chloride systems MCl_3–HCl–H_2O–1M D2EHPA (in mineral spirits), where M designates Sm, Nd, and trivalent Ce cations, was studied over an extensive range of concentrations. The metal aqueous concentration was varied from 0.05 to 2.0 M and the aqueous acidity ranged from 0.3 to 1.0 M. The equilibrium curves, with the aqueous acidity as a parameter, exhibited a behavior typical of other lower lanthanides. Further, trivalent cerium behaved the same as other trivalent rare earths. A study of the binary extraction systems Sm–Nd, Sm–Ce, and Nd–Ce indicated that the separation factor remained nearly constant for all conditions studied. The arithmetic averages were $\beta_{Sm,Nd} \sim 8.4$, $\beta_{Nd,Ce} \sim 2.0$, and $\beta_{Sm,Ce} \sim 18.9$. In the ternary system Sm–Nd–Ce, the separation factor of each combination pair of elements remained essentially constant for all conditions studied. Furthermore, the separation factor of each pair of elements in the ternary system remained the same as in the case where each pair of elements is extracted together. (auth)

92 SEPARATION OF THORIUM, URANIUM, AND NEPTUNIUM ON CHROMATOGRAPHIC COLUMNS LOADED WITH AMMONIUM 12-MOLYBDOPHOSPHATE. Ganzerli-Valentini, M. T.; Maxia, V.; Meloni, S.; Martinelli, A.; Rollier, M. A. (Univ., Pavia, Italy). J. Radioanal. Chem.; 11: No. 2, 179-87(Aug 1972).

The separation of thorium, uranium, and neptunium using chromatographic columns loaded with ammonium 12-molybdophosphate (AMP) was carried out in different media with variable amounts of the elements. Columns of different sizes were used. Good separation yields were obtained, and the recovery of the elements was always greater than 95%. The use of AMP columns appears to be a useful method in the analytical chemistry of these actinide elements and it is particularly valuable in the purification and recovery of actinides in the 4^+ oxidation state. (auth)

93 MECHANISM OF EXTRACTION OF MOLYBDENUM AND TUNGSTEN BY QUATERNARY AMMONIUM SALTS. Chichagova, G. N.; Ivanov, I. M.; Gindin, L. M.; Basov, A. S.; Chernikova, L. S. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk; No. 2, 65-71(Mar 1972). (In Russian).

The effect of varying the conditions was studied on the extraction of Mo and W by tetraoctylammonium chloride (TOAC) and by a trialkylbenzylammonium chloride (TABC) (in which the alkyl radicals were C_7 to C_9). TOAC was used in a 0.1 mole/l solution in toluene, and TABC was diluted to 0.49 to 0.66 M in xylene, for the extraction tests with aqueous solutions of either sodium molybdate (0.043 to 0.055 mole Mo/l) of sodium tungstate (0.025 to 0.048 mole W/l). Extraction of Mo and W from alkaline solutions in the form of WO_4^{2-} and MoO_4^{2-} was confirmed by "solvate number" determinations. An increase in the acidity of the aqueous phase sharply increases the extraction coefficients for both Mo and W, and polymerization of the metal occurs, depending on the initial concentration, e.g., $[Mo_nO_{2n+2}(OH)_{2n-2}]^{2-}$. (K.S.W.)

94 CHROMATOGRAPHIC PURIFICATION OF FISSION PRODUCT XENON. Liner, Jerome (Mound Lab., Miamisburg, Ohio). J. Chromatogr. Sci.; 9: 554-9(Sep 1971).

A chromatograph was developed to separate krypton-85 from fission product xenon. Two columns were built to be run alternately. Each was 30.5 cm long internally finned, with a feed chamber volume of 7.02 liters. The krypton-85 content was reduced from 10^{-4} mole percent to 8.05×10^{-11} mole percent at a rate of 15 liters/hr of purified xenon. (auth)

95 CATION EXCHANGE IN ACETIC ACID SOLUTIONS. Jha, S. K.; de Corte, F.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta; 62: No. 1, 163-76(Nov 1972).

Adsorbabilities of some 60 elements as a function of acetic acid molarity in the range 1 to 17.4M were studied. The separations, technetium from molybdenum, iron from cobalt and manganese, and gold from silver and copper are described. A qualitative interpretation of the adsorbabilities was attempted. (auth)

Inorganic, Organic, and Physical Chemistry

96 (AECL–4259) CHEMISTRY AND MATERIALS DIVISION PROGRESS REPORT, APRIL 1–JUNE 30, 1972. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1972. 119p. (PR-CMa–21). Dep. NTIS (U. S. Sales Only). AECL $2.50.

Research progress in solid-state science, chemistry, and materials science is reported. Lists of published papers, reports, and lectures reporting the work are included. (M.C.G.)

97 (ORNL–4791) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 20, 1972. (Oak Ridge National Lab., Tenn.). Aug 1972. Contract W-7405-eng-26. 185p. Dep. NTIS.

Separate abstracts were prepared for 14 sections. (M.C.G.)

For abstracts of individual sections see: 99–104, 114, 134, 145–147, 191, 1581, and 1641.

Chemical and Physicochemical Properties

Refer also to abstracts 69, 146, 147, 191–193, 195, 196, 199, 678, 688, 1495, and 1641.

98 (FRNC-TH-244) STUDY OF THE NEPHELAUXETIC EFFECT IN A SERIES OF CITRIC COMPLEXES OF THE LANTHANIDES. Hubert, Solange (Paris Univ. (France)). [nd]. 41p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The formation constant, β_2, for MCit H Cit^{2-} lanthanide type complexes was determined. The variation of β_2 as a function of Z can be explained by the lanthanide contraction and the nephelauxetic effect. In order to accurately determine the value of β_2, five different lanthanide mixtures labeled with their radioactive isotopes were used: ^{140}La–^{144}Ce–^{142}Pr–^{147}Nd–^{151}Pm and ^{153}Gd; ^{153}Sm–^{152}Eu–^{153}Gd and ^{160}Tb; ^{152}Eu–^{160}Tb–^{165}Dy and ^{166}Ho; ^{165}Dy–^{166}Ho–^{171}Er and ^{170}Tm; ^{166}Ho–^{171}Er–^{170}Tm–^{169}Yb and ^{177}Lu. The distribution of these isotopes in the (Li^+, H^+, ClO_4^-–H_3Cit)–TTA–benzene (solvent extraction) system was measured.

The distribution coefficient for these elements was measured as a function of the pH and the citric acid concentration. A radiometric analysis of the different aqueous and organic phases was effected using γ spectrometry. (France)

99 (ORNL-4791, pp 75-101) AQUEOUS SYSTEMS. Aug 1972.
In Chemistry Division annual progress report for period ending May 20, 1972.

ACRYLIC ACID POLYMERS—H_2O–poly(acrylic acid), diffusion of sodium in
CHROMIUM—sorption of trivalent and hexavalent, by inorganic and organic ion exchangers
DESALTING—filtration methods for
—Donnan softening for
—polymer evaluation for use in
ELECTRODES—potential of silver/silver chloride, recalculation of
ELECTROLYTES—osmotic coefficients of
FILTRATION—development of cross-flow
ION EXCHANGE MATERIALS—diffusion in, radiometric methods for measurement of
—filtration through membranes of, Nernst–Planck equations for hyper-
ION EXCHANGERS—complex ion identification on, laser Raman spectroscopy for
LANTHANUM CHLORIDES—thermodynamic properties of hydrochloric acid solutions of
—$LaCl_3$–NaCl, thermodynamic properties of hydrochloric acid solutions of
POLYMERS—properties for use in desalting of aqueous solutions
POTASSIUM CHLORIDES—$CaCl_2$–KCl, thermodynamic properties of hydrochloric acid solutions of
RARE EARTHS—ion exchange reactions of, tetrad effect in
SEWAGE—filtration of municipal, cross-flow
SODIUM—diffusion in poly(acrylic acid)–water systems
SODIUM CHLORIDES—solubility in organic compound–water systems
WATER—separation of contamination from, development of methods for (M.C.G.)

100 (ORNL-4791, pp 101-4) MOLTEN SALTS AND RELATED NONAQUEOUS [illegible] Aug 1972.
In Chemistry Divi[illegible]ress report for period ending May 20, 1972.

ALKALI METAL F[illegible]ATES—alkali metal fluoroberyllates–alkali [illegible], phase studies on
ALKALI METAL IODIDES [illegible]ali metal fluoroberyllates–alkali metal iodides, phase s[illegible]e on
LITHIUM FLUOROBORATES—$LiBF_4$–LiF, phase diagram of
—enthalpy of
RARE EARTH HALIDES—formation free energy of, emf studies on
URANIUM FLUORIDES UF_4—fusion entropy of
ZIRCONIUM FLUORIDES—fusion entropy of (M.C.G.)

101 (ORNL-4791, pp 106-14) ELECTROCHEMISTRY. Aug 1972.
In Chemistry Division annual progress report for period ending May 20, 1972.

COPPER—separation from distillation plant blowdown streams, electrochemical
DESALTING—electrochemical methods for
ELECTROLYTES—electric conductivity of molten salt
OXYGEN—monitoring in aqueous solutions at ppB level, electrochemical
—determination in aqueous solutions, packed-bed electrodes for
SEAWATER—processing for hardness and pH control, electrochemical
SOLUTIONS—monitoring oxygen content at ppB level in flowing aqueous, electrochemical
—analysis of aqueous, for oxygen, packed-bed electrodes for
TITANIUM—electrochemical behavior of
WATER—processing for hardness and pH control, electrochemical (M.C.G.)

102 (ORNL-4791, pp 115-33) NEUTRON AND X-RAY DIFFRACTION. Aug 1972.
In Chemistry Division annual progress report for period ending May 20, 1972.

CEMBRENE—crystal structure of
HYDROGEN IONS—description of tri-aquated $H_3O_3^+$
HYDROGEN ISOTOPES—fractionation in crystals containing both short and long hydrogen bonds
LITHIUM HYDROXIDES—crystal structure of monohydrate of, neutron diffraction studies on
MOLECULES—conformation of isolated, use of crystal structure for prediction of
—torsional potential of
STEROIDS—molecular structure studies on
SUCROSE—crystal structure of, neutron diffraction studies on
UREA, HYDROXY-—molecular structure of
WATER—atom pair correlations for liquid
—molecular structure of
YTTRIUM OXALATES—crystal structure of, neutron diffraction studies on
—hydrogen isotope fractionation in (M.C.G.)

103 (ORNL-4791, pp 149-52) ELECTRON SPECTROSCOPY. Aug 1972.
In Chemistry Division annual progress report for period ending May 20, 1972.

COMPLEXES—binding energies of, photoelectron spectroscopic studies on
INORGANIC COMPOUNDS—bonding in, photoelectron spectroscopic studies on
METHANE—photoelectron spectra of halogen-substituted
TUNGSTEN—oxide layer on, photoelectron spectroscopic studies on
X RADIATION—analysis by photoelectron spectroscopy (M.C.G.)

104 (ORNL-4791, pp 152-6) ATOMIC AND MOLECULAR COLLISIONS. Aug 1972.
In Chemistry Division annual progress report for period ending May 20, 1972.

ALKALI METAL HALIDES—electron sputtering of
ALKALI METALS—ionization and stripping in collisions with gaseous molecules
COBALT—reactions with heavy ions, cross sections for production of x rays in
GOLD—reactions with heavy ions, cross sections for production of x rays in
IODINE—ionization in heavy-ion collisions, inner-shell
IONIZATION—mechanisms of inner-shell
IRON—reactions with heavy ions, cross sections for production of x rays in
MERCURY—excitation by molecular collisions
NEODYMIUM—reactions with heavy ions, cross sections for production of x rays in
TIN—reactions with heavy ions, cross sections for production of x rays in
TITANIUM—reactions with heavy ions, cross sections for production of x rays in
ZIRCONIUM—reactions with heavy ions, cross sections for production of x rays in (M.C.G.)

105 (TID-26188) SOLVENT EXTRACTION STUDIES USING HIGH-MOLECULAR-WEIGHT AMINES. Progress Report. McDonald, Curtis; Rhodes, Thornton (Southern Univ., Baton Rouge, LA. (USA)). 10 Oct 1972. Contract AT(40-1)-4152. 8p. Dep. NTIS.

Optimum conditions for the formation and various properties of ruthenium complexes with 5,6-diamino-4-pyrimidinol sulfate were studied. The findings are tabulated. Studies have been initiated on complexes formed by the reactions of alloxane-5,6-dioxime with transition metals. Only Ni, Pd, and Cu were precipitated among the common transition metals. (J.G.B.)

106 (Y-DJ-8043) USE OF SCREENING EXPERIMENTS IN THE OPTIMIZATION OF A CHEMICAL PROCESS. Gerwels, J. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). [nd]. 25p. (CONF-721028-1). Dep. NTIS.

From 16th annual fall technical conference of American Society for Quality Control; Knoxville, TN. (19 Oct 1972).

This series of experiments strongly indicates that green castings of carbon foam can be made that are relatively free of unacceptable voids, cracks, black streaks, and fractures. Indications are that the number of acceptable voids can be reduced. The results of these experiments indicate the importance of the combination of turntable speed and blade position, time used in mixing the chemicals, and rotation speed of the mixing blade. (auth)

107 PURIFICATION OF ALKALI HALIDES. Rosenberger, Franz (Univ. of Utah, Salt Lake City). pp 3-69 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Properties of alkali halides that must be considered for the application of various purification techniques are discussed. Various aspects of purification, including container problems, methods of purification, fractional crystallization, fractional distillation, puri-

fication schemes, and evaluation of purification, are considered. (144 references) (J.G.B.)

108 PROCEEDINGS OF THE 2nd CONFERENCE ON APPLIED PHYSICAL CHEMISTRY, VESZPREM, HUNGARY, AUGUST 2–5, 1971. VOLUME 2. Buzas, I. (ed.). Budapest; Akademiai Kiado (1971). 738p. (CONF-710844-(Vol.2)).

Volume II of the proceedings includes 86 papers on various aspects of chemical engineering, including unit operations, processes and procedures, and pharmaceutical technology. Two papers have been abstracted separately for NSA. (J.G.B.)

For abstracts of individual papers see: 109 and 874.

109 METHODS OF PREPARATION OF PURE RARE EARTH COMPOUNDS: SEPARATION OF EUROPIUM FROM OTHER RARE EARTH ELEMENTS. Czegledi, B.; Csovari, M.; Sarkadi-Nagy, B. (Mecsek Ore Mining Enterprise, Pecs, Hungary). pp 421-7 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 2. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844– (Vol.2).

Europium in the divalent state is easier to separate from Gd^{3+} and other rare earths of higher valency than is Eu in the trivalent state. A zinc amalgam was used to reduce Eu^{3+} to Eu^{2+}, which was then precipitated as $EuSO_4$. Europium oxide (Eu_2O_3) of 99.9% purity was obtained by this method. (J.G.B.)

110 VIBRATIONAL SPECTRA AND FORCE CONSTANTS OF THE HEXACYANO COMPLEXES OF MANGANESE(I), TECHNETIUM(I), AND RHENIUM(I). Krasser, W.; Bohres, E. W.; Schwochau, K. (Kernforschungsanlage, Juelich, Ger.). Z. Naturforsch.; 27a: No. 8-9, 1193-6(1972). (In German).

The infrared and Raman spectra of the complex salts $K_5[Mn(CN)_6]$, $K_5[Tc(CN)_6]$, and $K_5[Re(CN)_6]$ were recorded in the range from 4000 to 40 cm^{-1}. All expected fundamental vibrations were observed and could be assigned to the irreducible representations of the symmetry point group O_h. The calculation of the force constants is based on the concept of the generalized valence force field. The low C-N-valence force constants indicate the relatively strong π-bonding character of the metal carbon bond, which is especially pronounced for $K_5[Tc(CN)_6]$. (auth)

111 SEARCH FOR NEW RADIOPROTECTIVE AGENTS. PART XX: SYNTHESIS OF SOME NEW SULFENAMIDES. Tulecki, J.; Kalinowska-Torz, J.; Plucinska, G.; Schmidt, M.; Skwarski, D. (Dept. of Chemical Tech. of Medicaments, Poznan, Poland). Ann. Pharm. (Poznan); 9: 25-32(1971). (In Polish).

By coupling 2- and 3-aminopyridine and 2-, 4-nitro- as well as 2,4-dinitrophenylsulfenyl chlorides, the following sulfenamides not described in the available literature were obtained: 2-(2′-nitrophenylosulfenamido)pyridine, 3-(2′-nitrophenylosulfenamido) pyridine, 2-(4′-nitrophenylosulfenamido)pyridine, 3-(4′-nitrophenylosulfenamido)pyridine, 2-(2′, 4′-dinitrophenylosulfenamido) pyridine, and 3-(2′, 4′-dinitrophenylosulfenamido)pyridine. The compounds were identified by elementary analysis. (auth) (NSA of Poland)

112 INFRARED SPECTRUM OF CHLORIDE COMPLEXES OF Ru(IV) EXTRACTED BY BIS(2-ETHYLHEXYL)AMINE. Neikova, E. A.; Vassilev, C.; Vratcheva, N. I. Compt. Rend. Acad. Bulg. Sci.; 24: No. 12, 1645-8(1971). (In French).

The extraction of Ru complexes was investigated by extracting 0.02 M Ru in different concentrations of HCl with an organic phase consisting of 25% bis(2-ethylhexyl)amine. A study of the infrared spectra yielded the fundamental frequencies of the reaction products of Ru chloride and the amine. At 0.008, 0.17, 1, and 5 M HCl, the following respective complexes were found: $[Ru(OH)_2(H_2O)_4]^{2+}$, $[Ru(OH)_2(H_2O)_2Cl_2]$, $[Ru(OH)_2Cl_4]^{2-}$, and $[Ru(OH)Cl_5]^{2-}$. (K.S.W.)

113 VIBRATIONAL SPECTRA OF PERTECHNYL CHLORIDE, TcO_3Cl. Guest, A. (Univ. of the West Indies, Mona, Jamaica); Howard-Lock, H. E.; Lock, C. J. L. J. Mol. Spectrosc.; 43: No. 2, 273-81(Aug 1972).

The vibrational spectra of pertechnyl chloride were measured over a temperature range and compared with those of perrhenyl chloride. There is considerable similarity. In addition the spectra are extremely similar to those of Tc_2O_7. It is postulated that splitting of the vibrational bands in both solid TcO_3Cl and ReO_3Cl at very low temperatures was caused by a phase change. (auth)

Isotope Effects

Refer also to abstracts 152, 189, and 190.

114 (ORNL–4791, pp 67-74) ORGANIC CHEMISTRY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

ACETOPHENONE—pyrolysis of
DEUTERIUM—effects on reactions of α-phenylethylamine with nitrous acid, isotope
NORBORNYL COMPOUNDS—rearrangements in, transformation graphs for
—hydride shifts in, mechanism of
SEXIPHENYL—preparation of
VINYL COMPOUNDS—preparation of (M.C.G.)

115 VIBRONIC SPECTRUM OF THE $^{13}C^{16}O_2^+$ ION. Koryazhkin, V. A. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 334-5(1972). (In Russian).

The isotopic effects in the spectrum of CO_2^+ were investigated on replacing the atom ^{12}C by the atom ^{13}C. The conclusion derived is that the CO_2^+ is nonlinear both in the ground state (bond angle is about 168°) and in the excited state (172°). (auth)

116 VIBRATIONAL SPECTRUM AND FORCE FIELD OF XENON TETROXIDE. McDowell, Robin S.; Asprey, Larned B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 57: No. 8, 3062-8(15 Oct 1972).

Infrared and Raman spectra are reported for $Xe^{16}O_4$ and $Xe^{18}O_4$ vapor. The infrared band contours are analyzed to give values for the Coriolis constants and the xenon isotopic frequency shift, and anharmonicity corrections are estimated for the fundamental frequencies. General quadratic force constants are calculated, using as constraints the $^{16}O-^{18}O$ and $^{129}Xe-^{132}Xe$ frequency shifts and the Coriolis constants. The force field is significantly different from those of RuO_4 and OsO_4. Valence stretching force constants are $f_r = 6.40 \pm 0.10$ mdyn/Å and $f_{rr} = -0.08 \pm 0.04$ mdyn/Å; the negative value of the interaction constant f_{rr} indicates that the bonding differs appreciably from that in the transition metal tetroxides. Standard-state thermodynamic functions for XeO_4 vapor are calculated for the temperature range 250 to 400°K. (auth)

117 ISOTOPE EFFECT ON VIBRATIONAL EXCITATION INDUCED BY COLLISION OF H_2 AND D_2 MOLECULES. Bergeron, Guy; Chapuisat, Xavier (Univ., Paris, Orsay). J. Chem. Phys.; 57: No. 8, 3436-40(15 Oct 1972).

Some effects of the rotational motion of a vibrating rotator on its collisionally induced vibrational excitation were studied for H_2 and D_2 molecules initially at rest colliding with a He atom. Whatever the collision energy, the vibrational energy transfers are almost equal, due to cancellation between two dynamically opposed effects (in terms of collisional adiabaticity): the rotational modulation effect on the vibrational coordinate favors the vibrational energy transfer in H_2, the frequency effect in D_2. Numerical results (derived from computed trajectories) are presented to confirm this interpretation. (auth)

118 DE-EXCITATION OF $CO_2(00^01)$ BY HYDROGEN FLUORIDES. Shin, Hyung Kyu (Univ. of Nevada, Reno). J. Chem. Phys.; 57: No. 8, 3484-90(15 Oct 1972).

Vibrational de-excitation of $CO_2(00^01)$ by HF and DF molecules was investigated on the basis of vibration-to-rotation energy transfer in the temperature range 300 to 2000°K. The calculation shows that the vibrational relaxation is very fast in both $CO_2(00^01)$–HF and $CO_2(00^01)$–DF collisions, and the results are in reasonable agreement with laser-excited fluorescence measurements around 350°K. For $CO_2(00^01)$–HF, an inverse temperature dependence of the relaxation time is found between 300 and 400°K; the relaxation time at 360°K was about 30% longer than that at 300°K. For this system the relaxation times changed from 0.023 μsec · atm at 300°K to 0.0035 μsec · atm at 2000°K. No inverse temperature dependence was found for $CO_2(00^01)$–DF. From a comparison with experimental data it is predicted that the de-excited states of CO_2 are (00^00) and (01^10), respectively, for the $CO_2(00^01)$–HF and $CO_2(00^01)$–DF relaxation processes. The difference in the final states is explained in terms of the relative efficiency of HF and DF in de-exciting $CO_2(00^01)$. Throughout the calculation, the effects of translational motion and molecular attraction on relaxation processes are considered. (auth)

119 ^{13}C IMPURITY EFFECT ON THE α_{2u} INFRARED EXCITON SPECTRUM OF THE BENZENE CRYSTAL. Laufer, J. C.; Kopelman, R. (Univ. of Michigan, Ann Arbor). J. Chem. Phys.; 57, No. 8, 3202-7(15 Oct 1972).

The ^{13}C shift for the α_{2u} molecular benzene mode was calculated to be -0.33 ± 0.04 cm^{-1}. This confirmed the previous assignment of the major pairwise molecular excitation exchange interactions for the α_{2u} vibrational exciton and enabled an exciton density-of-states to be picked for the pure crystal. The natural-abundance isotopically mixed benzene crystal density-of-states and its spectrum were calculated. Predicted in-band spectral resonances are consistent with published experimental data and facilitate their interpretation in terms of Davydov components, density-of-states peaks, band center, site shift, and exciton interactions. The implications and applications of the ^{13}C presence in "pure crystal" spectra are discussed. (auth)

120 BEBO CALCULATIONS. II. ARRHENIUS PARAMETERS AND KINETIC ISOTOPE EFFECTS FOR THE REACTIONS OF CH_3 AND CF_3 RADICALS WITH NH_3. Arthur, N. L.; McDonell, J. A. (La Trobe Univ., Bundoora, Australia). J. Chem. Phys.; 57: No. 8, 3228-34(15 Oct 1972).

The three-atom BEBO model was used to calculate Arrhenius parameters, tunneling corrections, and kinetic isotope effects for the reactions of CH_3 and CF_3 radicals with NH_3. The theoretical values are compared with the corresponding experimental results, and the polarity of the substrate, the effect of variation of the Pauling constant, the role of tunneling, and the rates of the reverse reactions are examined. (auth)

121 GAS-PHASE INFRARED SPECTRA OF HOF AND DOF. Appelman, Evan H. (Argonne National Lab., Ill.); Kim, Hyunyong J. Chem. Phys.; 57: No. 8, 3272-6(15 Oct 1972).

The infrared spectra of HOF and DOF in the gas phase were studied. From the analysis of rotational subbands, the fundamental frequencies were determined to be 3578.5, 1354.8, and 889.0 cm^{-1} for HOF; and 2643.5, 1003.9, and 891.1 for DOF. The respective values of the constants $(A'' - \bar{B}'')$ and $\bar{B}''$ are 18.37 and 0.86 cm^{-1} for HOF, and 9.79 and 0.81 cm^{-1} for DOF. (auth)

122 CATALYTIC EFFICIENCIES OF H_2O, D_2O, NO, AND HCl IN THE VIBRATIONAL RELAXATION OF HF AND DF. Blauer, J. A.; Solomon, W. C.; Sentman, L. H.; Owens, T. W. (Air Force Rocket Propulsion Lab., Edwards, Calif.). J. Chem. Phys.; 57: No. 8, 3277-81(15 Oct 1972).

The catalytic efficiencies of H_2O, D_2O, NO, and HCl in the vibrational relaxation of HF and of NO in the vibrational relaxation of DF were investigated over the temperature and total pressure ranges of 1000 to 4100°K and 0.1 to 0.3 atm, respectively. Measurements were made in an Ar diluent behind incident shock waves. The extent of vibrational excitation in HF was determined as a function of time by continuously monitoring the infrared emission intensity at 4150 ± 200 cm^{-1}. Water appears to relax HF principally by means of a direct transfer of vibrational energy (V–V) between the collision partners. Furthermore, its collisional efficiency was found to be in fair agreement with the results reported by others for the analogous process of HCl relaxation by H_2O. Nitric oxide was found to be at least an order-of-magnitude more efficient as a collision partner in the vibrational relaxation of HF than is known for either of the molecules N_2 or O_2. A small amount of data regarding the effect of HCl on the vibrational relaxation of HF was collected. Within the temperature range considered, its catalytic efficiency was found to be comparable to that of HF itself. (auth)

123 VIBRATIONAL RELAXATION OF HYDROGEN. Hopkins, Barbara M.; Chen, Hao-lin (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys.; 57: No. 8, 3161-6(15 Oct 1972).

The rates of vibrational relaxation of D_2 and HD were studied by laser-induced vibrational fluorescence. The relaxation times of D_2/HCl, HD/HCl, D_2/H_2/HCl, and D_2/HD/HCl mixtures at 296°K show cross sections of V → T, R energy transfer as $\sigma_{D_2-D_2} = 1.4 \pm 0.1 \times 10^{-22}$ cm^2, $\sigma_{D_2-H_2} = 1.4 \pm 0.1 \times 10^{-21}$ cm^2, $\sigma_{D_2-HD} = 8.2 \pm 1.0 \times 10^{-22}$ cm^2, $\sigma_{HD-HD} = 6.9 \pm 0.8 \times 10^{-22}$ cm^2, $\sigma_{HCl-D_2} = 4.0 \pm 0.4 \times 10^{-21}$ cm^2, and $\sigma_{HCl-HD} = 1.7 \pm 0.2 \times 10^{-20}$ cm^2. Cross section for V → V energy transfer from HCl to HD as $\sigma_{HCl-HD}^{V\to V} = 2.0 \pm 0.2 \times 10^{-20}$ cm^2. Comparison of vibrational relaxation rates among hydrogen isotopes and direct correlation between high temperature shock tube results and room temperature data reveal the importance of both rotational and translational motion in the process of vibrational energy transfer of hydrogen. (auth)

124 EQUILIBRIUM AND KINETIC ISOTOPE EFFECTS. Sicking, G. (Univ., Muenster, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 790-7(Aug 1972).

The equilibrium distribution effects of deuterium and of tritium between liquid water, hydrogen gas, and palladium hydride differ from one another in a characteristic manner. They are discussed in terms of zero-point energies. Direct measurements of the deuterium distribution between liquid water and palladium hydride yielded an uncommonly high equilibrium separation factor of about 9.2 at room temperature. This value is in good agreement with the calculation. The corresponding value for the tritium distribution is calculated to be about 12. From equilibrium distribution measurements of tritium between hydrogen and β-palladium hydride, the β phase isotherms of the pure palladium tritium system could be obtained. The principal vibration frequency of the triton in the palladium lattice works out as 7.1×10^{12} sec^{-1} at 25°C as expected. Combining the isotope effects of hydrogen diffusion in palladium (which are discussed here) with the equilibrium isotope effects mentioned above, one can calculate the ratio of the diffusion fluxes of two hydrogen isotopes in palladium electrodes. In the case of anodic dissolution, the predicted anodic hydrogen/deuterium separation factor of about 1.7 is confirmed by direct measurements and nearly independent of temperature. The cathodic separation factor, however, which governs the ratio of the H/D fluxes in the case of cathodic deposition, is calculated much too low compared with the experiment, which yielded a value of nearly 10 at 25°C. The discrepancy is based on an additional kinetic isotope effect of the surface reaction. (31 references) (auth)

125 ARGON MATRIX RAMAN AND INFRARED SPECTRA AND VIBRATIONAL ANALYSIS OF OZONE AND THE ^{18}O SUBSTITUTED OZONE MOLECULES. Andrews, Lester; Spiker, R. C. Jr. (Univ. of Virginia, Charlottesville). J. Phys. Chem.; 76: No. 22, 3208-13(26 Oct 1972).

Raman spectra of argon matrix-isolated ozone and oxygen-18 enriched ozones were obtained using reduced power argon ion laser excitation. Photodecomposition of ozone was sufficiently moderated to obtain excellent Raman spectra, with the following $^{16}O_3$ assignments: ν_1, 1104 cm^{-1}, very strong; ν_2, 701 cm^{-1}, strong; ν_3, 1038 cm^{-1}, weak. Infrared spectra provided complementary data: ν_1, 1105 cm^{-1}, very weak; ν_2, 704 cm^{-1}, weak; ν_3, 1040 cm^{-1}, very strong. Potential constants were calculated using vibrational fundamentals for six isotopic ozone molecules. An ozone valence angle of 116.3 ± 4° was calculated from four isotopic ν_3 assignments, in excellent agreement with the microwave value. (auth)

126 SPONTANEOUS AND GENERAL BASE-CATALYZED IODINATION OF PYRUVIC ACID AND ALKYL PYRUVATES. ACTIVATION PARAMETERS AND SOLVENT DEUTERIUM ISOTOPE EFFECTS. Hegazi, M.; Meany, J. E. (Central Washington State Coll., Ellensburg). J. Phys. Chem.; 76: No. 22, 3121-4(26 Oct 1972).

The iodinations of pyruvic acid and methyl and ethyl pyruvates were studied using a spectrophotometric method by following the disappearance of the triiodide anion at 353 nm. The spontaneous rates were determined over a wide range of temperatures from which the activation parameters were determined in H_2O and D_2O. For pyruvic acid, the free energy, $\Delta G^{\ddagger}$, enthalpy, $\Delta H^{\ddagger}$, and entropy, $\Delta S^{\ddagger}$, of activation were found to be very similar to the corresponding values as determined for the esters. The catalytic components, k_{cat}, involved in the general base-catalyzed iodination of methyl pyruvate in formate, acetate, and diethyl malonate buffers were determined and these values along with the value associated with the solvent-catalyzed component at 25.0°C allowed estimation of the Brønsted coefficient, $\beta = 0.55 \pm 0.06$. (auth)

127 VIBRATIONAL RELAXATION IN CO_2 WITH SELECTED COLLISION PARTNERS. I. H_2O AND D_2O. Buchwald, M. I.; Bauer, S. H. (Cornell Univ., Ithaca, N. Y.). J. Phys. Chem.; 76: No. 22, 3108-15(26 Oct 1972).

Density gradients were measured with a laser–schlieren technique in CO_2–H_2O and CO_2–D_2O mixtures behind incident shocks, at temperatures from 380 to 1200°K. Shock pressures ranged from 100 to 400 Torr; water concentrations from 1 to 9%. These data were reduced to vibrational relaxation times, which were found to increase with rising temperature, and which are in good agreement with recent ultrasonic measurements. At 400°K, $(P\tau_{CO_2-D_2O}) \approx 4(P\tau_{CO_2-H_2O})$. The vibrational relaxation times approach a common value of 4 10^{-8} sec/atm at 1000°K, and then decrease slowly with temperature. The shock tube results are compared with previous measurements and theoretical predictions. (auth)

128 ISOTOPE EFFECTS ON MOLECULAR IONIZATION YIELDS. AN EXTENSION OF THE PLATZMAN MODEL. Person, James C. (Argonne National Lab., Ill.). Radiat. Res.; 52: No. 1, 1-16(Oct 1972).

An analysis of isotope effects on molecular ionization yields (efficiencies) is given on the basis of a model that extends the Platzman discussion of the decay of superexcited states as a simple competition between preionization and neutral-product formation. The model is presented in terms of several parameters and the implications of changes of these parameters are investigated. The parameters include the quantum yields of direct ionization and of a new process, noncompetitive neutral-product formation (neutral products formed from states in which preionization is absent or slow in comparison with neutral-product formation). This process has only a moderate influence on isotope effects unless it is producing nearly all of the neutral products. Another parameter ρ gives the isotope effect on the competition of preionization and neutral-product formation, and allows for a general mass dependence. The magnitude of ρ is discussed and a detailed analysis of deuterium isotope effects observed in the photoionization of methyl bromide in the energy range of 10.5 to 11.4 eV provides estimates of ρ for this example. (auth)

129 CONCENTRATION DEPENDENCES OF THE BINARY DIFFUSION COEFFICIENTS OF THE SYSTEMS H_2–Ne, D_2–Ne,

H_2–N_2, D_2–N_2, H_2–Ar, AND D_2–Ar AT 1 ATM PRESSURE AND 300 K. Harris, K. R. (Simon Fraser Univ., Burnaby, B. C.); Dunlop, P. J.; Bell, T. N. Can. J. Phys.; 50: No. 14, 1644-7 (15 Jul 1972).

Binary diffusion coefficients were measured as a function of concentration for the systems H_2–Ne, D_2–Ne, D_2–N_2, H_2–Ar, and D_2–Ar at 1 atm pressure and 300°K. Similar data were previously presented for the system H_2–N_2. As predicted by the Chapman–Enskog theory, the concentration dependences of the diffusion coefficients for the systems containing deuterium are somewhat less than for the corresponding systems containing hydrogen. The data for the systems containing Ne and N_2 indicate that there may be differences between the parameters required to describe the assumed spherical intermolecular potentials for the systems H_2–Ne and D_2–Ne, and also for the systems H_2–N_2 and D_2–N_2. The concentration dependences of the diffusion coefficients of all six systems are, within the estimated experimental error of ±0.2%, linear in the mole fraction of the heavier component in each system, x_2. (auth)

130 pH-DEPENDENCE, ISOTOPE EFFECT, AND PRODUCTS OF FLAVIN-SENSITIZED PHOTODECARBOXYLATION AND PHOTODEHYDROGENATION. Haas, W.; Hemmerich, P. (Univ., Konstanz, Ger.). Z. Naturforsch.; 27b: No. 9, 1035-7(Sep 1972).

The pH-dependence of flavin-sensitized photodehydrogenation and oxidative photodecarboxylation shows a change of reaction rate with an apparent pK of about 5.5. This "photo-pK" is attributed to the pK of a covalent flavin-substrate intermediate. Carboxylates R–COO^- react by decarboxylation, the nature of R determining only the rate of reaction. The acids R–COOH themselves are unreactive, unless functionally substituted at the α-carbon. No kinetic isotope effect was found for the decarboxylation. The benzyl groups of the alkylated dihydroflavins and the benzaldehyde formed in the photoreductions showed full isotope retention of the starting CH or CD equivalents. (M.C.G.)

131 EFECT OF ELECTROLYTE CONCENTRATION ON FLUIDITY AND STRUCTURE IN DEUTERIUM OXIDE. MacDonald, J. C. (Fairfield, Univ., Conn.). Electrochim. Acta; 17: No. 11, 1965-76(Nov 1972).

The effect of electrolyte concentration on the fluidity of forty-three deuterium oxide solutions of nine different salts was evaluated in terms of the parameters of the Arrhenius and Eyring equations, and in terms of the structural properties of the solvent. It is demonstrated that the solutes can be grouped into three classes depending upon the type of solvation, positive or negative, between each ion and the solvent. Class I consists of negatively hydrated cations and anions; Class II consists of small positively hydrated cations and negatively hydrated anions; Class III consists of positively hydrated cations and anions. These effects are compared with previous data for ordinary water: no significant differences exist. (auth)

132 ZIRCONIUM(IV) AND HAFNIUM(IV) COMPLEXES OF α-HYDROXY CARBOXYLATES, LACTATES, MANDELATES, AND ISOPROPYLMANDELATES. STEREOSPECIFICITY IN EIGHT-COORDINATE COMPLEXES. Larsen, E. M.; Homeier, E. H. (Univ. of Wisconsin, Madison). Inorg. Chem.; 11: No. 11, 2687-92(Nov 1972).

The infrared spectra of deuterated (d_4) and protonated tetrakis-(dl-mandelato)zirconium(IV) and -hafnium(IV) are indicative of a structure containing considerable hydrogen bonding. The neutral stoichiometric tetrakis product from aqueous solution is obtained only with the racemic ligand, suggesting that dl ligand pairs provide a stereospecificity suitable for the formation of stabilizing hydrogen bonds which ligands of one handedness do not provide. A polymeric structure possessing bridging ligand pairs between metal ions is proposed. In acetonitrile, mandelic acid reacts with zirconium tetrachloride by anion replacement, to yield a mixture of monochlorotris(mandelato)zirconium and tetrakis(dl-mandelato) zirconium(IV) with an infrared spectrum different from that of the aqueous polymeric product. (auth)

133 METAL ISOTOPE EFFECT ON METAL-LIGAND VIBRATIONS. Nakamoto, Kazuo (Marquette Univ., Milwaukee). Angew. Chem. Int. Ed. Engl.; 11: No. 8, 666-74(Aug 1972).

Exploitation of the isotope effect using heavy metal isotopes makes it possible to give clear-cut assignments of the metal-ligand vibrations in the ir and Raman spectra of complex compounds. The results previously obtained with this method and their current limitations form the subject of this report. The effects of ^{62}Ni on spectra of nickel complexes are shown. Data are also given on effects of ^{110}Pd, ^{65}Cu, ^{68}Zn, ^{53}Cr, and ^{124}Sn on spectra of their complexes. (M.C.G.)

Isotope Exchange and Isotope Separation

Refer also to abstracts 81, 185, 411, and 412.

134 (ORNL-4791, pp 52-61) ISOTOPE CHEMISTRY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

CARBON ISOTOPES—separation by exchange between cyanides and cyanohydrins
—separation of, COCO process for
CESIUM—separation from aqueous solutions by solvent extraction using triphenylcyanoboron and tetraphenylboron
COBALT ISOTOPES—separation by ion exchange
FUSED SALTS—spectra of, laser Raman
RUBIDIUM—separation from aqueous solutions by solvent extraction using triphenylcyanoboron and tetraphenylboron
SULFUR FLUORIDES—analysis for sulfur-32 and sulfur-34 by mass spectroscopy
SULFUR ISOTOPES—separation by isotopic exchange
SULFUR-32—determination in sulfur hexafluoride by mass spectroscopy
SULFUR-34—determination in sulfur hexafluoride by mass spectroscopy (M.C.G.)

135 HIGH ENERGY REACTION KINETICS USING A HARD-SPHERE MODEL. Malcolme-Lawes, D. J. (Yale Univ., New Haven). J. Chem. Soc., Faraday Trans., II; 68: No. 9, 1613-22(1972).

A model of chemical reaction is described for atom-diatom reactions above threshold energies. Using a hard-sphere approximation the model is applied to the reaction of tritium with H_2, D_2 and HD. The results, which compare favorably with more exact theoretical treatments, are analyzed in terms of a low energy "end on" abstraction reaction and a high energy stripping mode of reaction. (auth)

136 PREPARATION OF DEUTERATED ORGANIC COMPOUNDS FROM ACTIVATED ORGANIC HALIDES BY REDUCTION WITH ZINC–DEUTERIUM OXIDE. Trzupek, L. S.; Stedronsky, E. R.; Whitesides, G. M. (Massachusetts Inst. of Tech., Cambridge). J. Org. Chem.; 37: No. 21, 3300-3(20 Oct 1972).

Reductive elimination of halogen from α-halo esters with zinc and deuterium oxide in polar aprotic solvents provides a convenient method for the preparation of the corresponding α-deuterated substances. The procedures developed for carrying out these transformations can be applied to the synthesis of large quantities of either mono- or dideuterated esters with good isotopic purity. Several isolated experiments suggest that this method should also be applicable to the conversion of α-halogenated nitriles and amides to the corresponding α-deuterated materials; when applied to the reductive deuteration of α-halogenated ketones and acid chlorides, the isotopic purities of the deuterated products are lower. This technique for the synthesis of α-deuterated esters is superior to the base-catalyzed exchange techniques in general use when the prerequisite α-halogenated analogs are available, both in its economical use of deuterium oxide and in its ability to introduce a single deuterium atom into a methyl or methylene group containing multiple equivalent exchangeable protons. (auth)

137 INVESTIGATION OF ISOTOPE ION MOBILITIES OF THE POLYISOTOPIC ELEMENTS IN MOLTEN SALTS AS ILLUSTRATED BY AN EXAMPLE OF TIN ISOTOPES. Lyubimov, V. N.; Tikhomirov, I. A.; Golyshev, S. I. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk; No. 2, 8-14(Mar 1972). (In Russian).

The correlation between mobilities of separate isotope ions U_i and the polyisotopic element as a whole U_e^0 is investigated. The general formula is deduced for the calculation of the enrichment coefficient of each separate isotope $\epsilon_i = (U_i - U_e^0)/U_e^0$, which is equal to the relative increment of concentration of this isotope as compared with its initial concentration on the length of the separation tube, which is the height of an equivalent theoretical plate. It is illustrated by an example of tin isotopes that in electromigration of ions in molten $SnCl_2$ the quantity ϵ_i is a linear function of mass difference of the given isotope and the atomic weight of the element with the initial isotope composition. At 450°C the mass effect μ_+ of Sn^{2+} ions equals to –0.064 if it is calculated as the mean of all μ_i values. (auth)

138 HOMOGENEOUS ISOTOPE EXCHANGE BETWEEN THALLIUM(I)- AND THALLIUM(III) DIETHYLDITHIOCARBAMATES IN ORGANIC SOLVENTS. Hradilova, E.; Stary, J. (Technical Univ., Prague). Radiochem. Radioanal. Lett.; 11: No. 6, 343-9(20 Oct 1972).

The kinetics of the isotope exchange reaction between thallium(I)- and thallium(III)-204 diethyldithiocarbamate in carbon tetrachloride was studied in detail. The rate constant (1.7×10^3 $mol^{-1}.l.sec^{-1}$ at 20°C) is 6 to 8 orders higher and the activation energy (9300 $cal.mol^{-1}$) is about the half of the corresponding values for thallium(I)–thallium(III) exchange reaction in aqueous solution. The type of solvent used has only a small influence on the kinetics. (auth)

Feed Materials Processing

Refer also to abstract 60.

139 APPLICATION OF THREE-PHASE SYSTEMS IN CHEMICAL TECHNOLOGY. Csovari, M. (Mecsek Ore Mining Enterprise, Pecs, Hungary); Czegledi, B.; Kuzin, I. A. pp 145-52 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844–(Vol.1).

A process for the recovery of scandium from uranium plant waste liquors was developed using a three-phase system of anion exchange resin–H_2SO_4 solution–kerosene solution of bis(2-ethylhexyl) phosphate (HDEHP). Distribution coefficients for Sc(III), Fe(III), and U(VI) in the system are tabulated. Selective Sc desorption is possible using this method. (J.G.B.)

140 RECOVERY OF URANIUM FROM WET-PROCESS PHOSPHORIC ACID. Hurst, Fred J.; Crouse, David J.; Brown, Keith B. Ind. Eng. Chem., Process Design Develop.; 11: No. 4, 122-8(Jan 1972).

A two-cycle process for recovering U by extraction with bis(2-ethylhexyl)phosphate plus trioctylphosphine oxide in an aliphatic diluent was developed and demonstrated successfully in benchscale mixer-settler tests. The U is recovered from the solvent and concentrated by reducing it to the less extractable tetravalent form with ferrous Fe contained in reduced process raffinate. This solution is oxidized and processed in a second cycle with the same extractant. In the second cycle the U is stripped from the solvent with ammonium carbonate solution and recovered as a high-grade (>97% U_3O_8) product. Overall recovery of U is ~95%. In the bench-scale tests, losses of the relatively expensive solvent to the aqueous raffinate were satisfactorily low (<0.1 ml/l). Chemical reagent costs for the process are estimated at < $1.00/lb of recovered U_3O_8. (Metals Abstr.)

Radiation Chemistry

Refer also to abstracts 12, 96, 97, 108, 183, 185, 190, 874, 885, and 1580.

141 (AECL–4066) PULSE RADIOLYSIS. A Comprehensive Bibliography, April 1969–December 1970. Greenshields, H.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1972. 46p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

A search of abstract and indexing sources for the period April 1969 to December 1970 provided most of the material that appears in this supplementary bibliography. The sources searched were Nuclear Science Abstracts, Chemical Abstracts, and Science Citation Index (S.C.I.). The 303 references are listed in broad subject groups and are sub-arranged by year, latest publication date first. The entries are alphabetically ordered by authors' surname, then by title. Each entry is numbered serially and the number of the first and last entry on each page is supplied to facilitate entry location. An alphabetical author index is included and an abbreviated title for each paper is entered under the first author quoted. Title entries are arranged in alphabetic sequence under each author. Co-authors are referenced so that the total authorship of each paper can be established. (auth)

142 (CONF-720530–6) THERMAL ANNEALING OF RADIATION DAMAGE IN NaCl CRYSTALS STUDIED BY POSITRON ANNIHILATION TECHNIQUES. Nicholas, J. B.; Tumosa, C. S.; Ache, H. J. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry). 1972. 14p. Dep. NTIS.

From twentieth annual meeting of the Radiation Research Society; Portland, OR. (14 May 1972).

The thermal annealing of radiation damage induced by gamma radiation in NaCl crystals was studied by positron annihilation techniques. The results show that the concentration of positron annihilation centers (A-center) decreases quickly at first upon heating, but then more slowly until a very slowly decreasing region, a pseudo plateau is reached. The A-center concentrations at which these pseudo plateaus are obtained depend on the temperatures at which the annealing processes are carried out. The kinetics of the annealing as observed by the positron annihilation technique is consistent with a bimolecular reaction model. The experimentally obtained activation energy for this process is about 1.2 eV, which suggests the elimination of positive ion vacancies aggregates, which act as positron annihilation centers, by migrating anion vacancies at elevated temperatures. (auth)

143 (COO–690–46) TECHNICAL PROGRESS REPORT, JULY 1, 1971–AUGUST 1, 1972. (Colorado Univ., Boulder). 1972. Contract AT(11-1)-690. 53p. Dep. NTIS.

Studies on chemical and conformational changes produced in proteins after gamma irradiation are summarized. Three different protein systems were used: dry solid egg white lysozyme, a lysozyme DNA complex, and rabbit eye lens. The latter two systems were studied on a preliminary level. Salt fractionation procedures followed by slab gel electrophoresis were used to separate damaged and undamaged molecules. Results on irradiated solid lysozyme demonstrated that main chain fission occurs on irradiation, as well as crosslinking and chemical changes leading to destruction of conformation. (auth)

144 (COO–958–36) PROPERTIES OF SOLVATED ELECTRONS AND ASSOCIATED SPECIES IN METAL SOLUTIONS AND KINETICS OF ELECTRON- AND PROTON-TRANSFER REACTIONS. Progress Report, September 16, 1971–September 15, 1972. Dye, James L. (Michigan State Univ., East Lansing. Dept. of Chemistry). [nd]. Contract AT(11-1)-958. 11p. Dep. NTIS.

The use of cyclic polyethers to dissolve alkali metals in a number of amine and ether solvents permitted determination of the solvent and temperature dependence of the spectra of e^-_{solv}, Na^-, and K^-. Comparison with the results of pulse-radiolysis shows that the presence of the alkali cation and/or the cyclic ether shifts and broadens the band of e^-_{solv}. A study of the dependence of the spin-pairing process in metal-ammonia solutions on the nature of the cation was initiated. Protonation kinetics of the anthracene radical anion showed the presence of both second-order and first-order processes (in the radical anion). (M.C.G.)

145 (ORNL–4791, pp 62-6) RADIATION CHEMISTRY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

AMMONIA—effects on ozone yields from flash photolysis and pulse radiolysis of oxygen
CERIUM—reduction of tetravalent, by hydrogen peroxide in sulfuric acid solutions
HYDROGEN—effects on ozone yields from flash photolysis and pulse radiolysis of oxygen
ORGANIC ACIDS—radiolysis of dicarboxylic, decarboxylation in
OXYGEN—radiolysis of, effects of various additives on ozone yields from pulse
—photolysis of, effects of various additives on ozone yields from flash
OZONE—yields from pulse radiolysis and flash photolysis of oxygen
SULFUR FLUORIDES—effects on ozone yields from flash photolysis and pulse radiolysis of oxygen
WATER—effects on ozone yields from flash photolysis and pulse radiolysis of oxygen (M.C.G.)

146 (ORNL–4791, pp 133-45) INFRARED AND RAMAN SPECTROSCOPY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

ALKALI METAL CARBONATES—spectra of molten, Raman
BERYLLIUM FLUORIDES—polymers, Raman spectra of crystalline and molten
CESIUM OXIDES—spectra of CsO_2, Raman
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SODIUM CHLORATES—spectra of molten and aqueous, vibrational Raman and ir
SODIUM OXIDES—spectra of NaO_2, Raman (M.C.G.)

147 (ORNL–4791, pp 145-9) MICROWAVE AND RADIO-FREQUENCY SPECTROSCOPY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

GAMMA RADIATION—effects on strontium nitrate monocrystals, ESR studies on
—effects on potassium hydroxylaminetrisulfonate monocrystals, ESR studies on
HYDROXYLAMINETRISULFONIC ACID—potassium salt, radiation effects on monocrystals of, ESR studies on γ
LIQUIDS—photolysis of, paramagnetic resonance studies of
PHOTOCHEMISTRY—paramagnetic resonance studies of
STRONTIUM NITRATES—radiolysis of monocrystals of, ESR studies on γ
TARTARIC ACID—photolysis of aqueous solutions of (M.C.G.)

148 STUDY OF THE RADIATION-INDUCED CROSS-LINKING OF POLYCHLOROPRENE IN LATEX. Tarasova, Z. N.; Fl'kina, I. A.; Kozlov, V. T.; Zagumennaya, T. I.; Kaplunov, M. Ya. (Moscow Inst. of Fine Chemical Tech.). Vysokomol. Soedin., Ser. A; 14: No. 8, 1782-7(Aug 1972). (In Russian).

The vulcanization of polychloroprene was carried out by γ-irradiation of the chloroprene latex with subsequent heat-treatment of the films prepared from this latex. The preliminary irradiation of the latex increases the rate and degree of cross-linking of the rubber in heat-treated films and improves their mechanical properties and stability towards thermal-oxidative ageing. (auth)

149 RADIATION-INDUCED GRAFTING OF METHYL METHACRYLATE FROM THE VAPOR PHASE ONTO CELLULOSE. Mirkamilov, I. M.; Azizov, U.; Sadykov, M. U.; Usmanov, Kh. U. Vysokomol. Soedin., Ser. A; 14: No. 8, 1704-8(Aug 1972). (In Russian).

A study was made of the grafting of methyl methacrylate from the vapor phase on the simultaneously and previously ^{60}Co γ-irradiated cellulose. It was found that the grafting by the former technique is accompanied by intensive homopolymerization of monomer. The grafting onto previously irradiated cellulose in the presence of water vapors proceeds at a higher rate without formation of the homopolymer. The graft copolymer yield depends on the cellulose type and decreases in the following sequence: cotton > flax > ramie. (auth)

150 VITREOUS SILICA. Hetherington, Gordon; Bell, Leslie W. (Thermal Syndicate Ltd., Wallsend, Eng.). pp 353-400 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

Vitreous silica is discussed under the following section headings: types and chemical composition; physical properties, including hardness, optical properties, irradiation effects, and thermal characteristics; chemical properties; gaseous and ionic diffusion; handling and preparation of vitreous silica containers; and applications. (84 references) (J.G.B.)

151 RADIOLYSIS OF MIXTURES OF CARBON DIOXIDE AND HYDROGEN. Beattie, W. H. (Los Alamos Scientific Lab., N. Mex.). Int. J. Chem. Kinet.; 4: No. 4, 463-77(Jul 1972).

The self-radiolysis of CO_2 in excess tritium ($^3H_2$) was studied at pressures of 0.1 to 1.0 atm, temperatures of –80 to +100°C, and in the presence of added H_2O, He, or Ar. The primary products of decomposition are CO and ^3H_2O. Secondary products are C^3H_4, $C_2{}^3H_4$, and a white polymer. The rates of disappearance of CO_2 and formation of products and G-values were measured. The disappearance of CO_2 initially obeys first order kinetics, then slows down with time at a rate depending on the initial pressure of $^3H_2$. The initial rates are proportional to pressures of CO_2 and $^3H_2$. They are independent of temperature, decreased by addition of H_2O vapor, and increased by addition of He or Ar. The proposed mechanism of decomposition of CO_2 and formation of products involves ionization of CO_2 followed by dissociative recombination forming CO and O. Then the O reacts with a hydrogen-containing species forming OH and H_2O, and a back reaction forms CO_2 from CO and OH. (auth)

152 ESR STUDY OF OH RADICALS ORIGINATING FROM WATER OF CRYSTALLIZATION OF CARBOXYLIC ACIDS. II. ROLE OF HYDROGEN BONDING IN SELECTIVE FORMATION OF OH RADICALS. Iwasaki, Machio; Minakata, Kayoto- Nunome, Keichi; Tagami, Kohji (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys.; 57: No. 8, 3187-93(15 Oct (1972).

The selective and stereospecific formation of OH radicals from water of crystallization by ionizing radiation was studied using an irradiated single crystal of dipotassium fumarate · $2H_2O$. The ESR results show that the major OH radicals produced with high selectivity are formed from a scission of the O–H bond having the shortest hydrogen bond distance among the four O–H bonds in the two inequivalent water molecules in a unit cell. In addition, evidence was obtained for the existence of a proton transferred from the water molecule to the neighboring carboxyl oxygen atom when the OH radical is formed. The crystal of dipotassium fumarate · $2D_2O$ gives OD radicals together with a large amount of OH radicals from H_2O contained as impurity, indicating a marked isotope effect on the formation of OH radicals. These results lead to the conclusion that proton tunneling through hydrogen bond plays an important role when radicals are formed from H_2O^+ by ionizing radiation. The minor OH radical, which differs in g anisotropy but has nearly the same orientation, is assigned to the unrelaxed form of the major OH radical, since the minor one having a larger g anisotropy and consequently interacting with surroundings more weakly was found to be less stable and to convert into the major species. At 77°K these OH radicals undergo small amplitude oscillation around the coordination bond between the radical oxygen atom and K^+. (auth)

153 DECOMPOSITION OF ALDRIN BY GAMMA RADIATION. I. IN ORGANIC SOLVENTS. Carp, A. E.; Liska, B. J.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Bull. Environ. Contam. Toxicol.; 7: No. 6, 321-30(1972).

The changes in Aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo, exo-5,8-dimethanonaphthalene) caused by γ radiation were studied by varying concentrations of Aldrin in hexane, cyclohexane, and acetone and by varying the total dose of γ radiation and the temperature of irradiation. Data are presented in tables and graphs. (M.C.G.)

154 DECOMPOSITION OF ALDRIN BY GAMMA RADIATION. II. IN LIPID SOLUTIONS. Carp, A. E.; Liska, B. J.; Ziemer, P. L. (Purdue Univ., Lafayette, Ind.). Bull. Environ. Contam. Toxicol.; 7: No. 6, 331-7(1972).

Aldrin (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo, exo-5,8-dimethanonaphthalene) was dissolved in corn oil or lard, irradiated using a 7500-Ci ^{60}Co source, and stored. Half of the samples were packed in air and half in nitrogen. The samples were stored in the dark at room temperature or at –20°C. The only treatment that produced any major alteration of the amounts of isomers formed was the temperature at which irradiation was accomplished. (M.C.G.)

155 ESR STUDIES ON RADICAL CONVERSIONS IN IRRADIATED SINGLE CRYSTALS OF SUCCINIC ACID. Muto, Hachizo; Inoue, Tetsushi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys.; 57: No. 8, 3220-7(15 Oct 1972).

ESR studies on radical conversions from primary to room temperature stable radicals in irradiated single crystals of succinic acid were carried out with aid of fumaric acid-doped crystals. Since in the doped crystals the spectrum of succinic acid anion was replaced by that of furmaric acid anion, it was possible to identify the spectrum arising from $\dot{C}H_2CH_2COOH$, which was postulated for a long time as a precursor of the room temperature stable radical $CH_3\dot{C}HCOOH$. It was further found that a part of $\dot{C}H_2CH_2COOH$ converts into $HOOC\dot{C}HCH_2COOH$ at –100°C and then the radical isomerization from $\dot{C}H_2CH_2COOH$ to $CH_3\dot{C}HCOOH$ takes place at –100 to –75°C following the conformational change, which is favorable to the intramolecular hydrogen transfer. The freshly formed $CH_3\dot{C}HCOOH$ radical has a different conformation from that of the room temperature stable species. The stable conformation is achieved by the 180° rotation around the C–C bond between the CH and carboxyl carbon atoms in the unstable species. Besides these, the conversion process from the succinic acid anion to $HOOC\dot{C}HCH_2COOH$ and $HOOCH_2CH_2C=O$ was studied. These results are based on the hyperfine and g tensors determined in the present work for CH_2CH_2COOH and unstable and stable $CH_3\dot{C}HCOOH$ as well as the stable anion. (auth)

156 ESR OF A RADICAL OF THE TYPE RNHNH IN X-IRRADIATED CYANOACETOHYDRAZIDE. Lin, W. C.; Nickel, J. M. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 57: No. 8, 3581-2(15 Oct 1972).

No nitrile type radical was observed in x-irradiated cyanoacetohydrazide. Instead, a stable radical that can be readily interpreted as $NCCH_2CONHNH$ was obtained. The main feature of the hyperfine structure was due to one nitrogen and one proton with further smaller splittings due to one more nitrogen and perhaps two more hydrogen. (M.C.G.)

157 ESR IDENTIFICATION OF SLATER CONFIGURATIONS AND OF EXCHANGE OF THE $(AsO_4)^{4-}$ RADICAL IN IRRADIATED FERROELECTRIC KH_2AsO_4 AND KD_2AsO_4 AND ANTIFERROELECTRIC $NH_4H_2AsO_4$ AND $ND_4D_2AsO_4$. Lamotte, B. (CEN, Grenoble, France); Gaillard, J.; Constantinescu, O. J. Chem. Phys.; 57, No. 8, 3319-29(15 Oct 1972).

The ESR study of the $\tilde{g}$ spectroscopic tensor and the As hyperfine tensor T_{As} of the $(AsO_4)^{4-}$ radical in crystals of ferroelectric

KH_2AsO_4(KDA) and KD_2AsO_4(DKDA) and antiferroelectric $NH_4H_2AsO_4$(ADA) and $ND_4D_2AsO_4$(DADA) shows that it is possible to identify selectively the Slater configurations of the radical in these crystals. In the paraelectric phase of these crystals dynamic low frequency fluctuations of $\tilde{g}$ and $\tilde{T}_{As}$ that correspond to an exchange between the "upper" and "lower" Slater configurations of the radical were observed. The temperature dependence of the correlation time of this process is close to Arrhenius laws: $\tau_c = \tau_{c_0} \exp(E_a/kT)$ with E_a = 0.21 eV for KDA, 0.27 eV for DKDA, 0.33 eV for ADA, and 0.43 eV for DADA. For the ammonium ADA and DADA salts, the passage through the Curie point shows drastic changes of the spectra of this radical. The analysis of the lines shows that they correspond to several distinct new Slater configurations of the radical. The general conclusion is that there exists a perturbed zone around the $(AsO_4)^{4-}$ radical which exhibits several different features characteristic of local symmetry, local order, and, with regard to the paraelectric phase, local dynamics. The question of antiferroelectric order in ammonium salts is also discussed with reference to the Nagamiya model. (auth)

158 CHEMICALLY INDUCED DYNAMIC ELECTRON POLARIZATION. I. A SIMPLE THEORY FOR H ATOM. Hutchinson, D. A.; Wong, S. K.; Colpa, J. P.; Wan, J. K. S. (Queen's Univ., Kingston, Ont.). J. Chem. Phys.; 57: No. 8, 3308-11(15 Oct 1972).

Anomalous ESR spectra were observed for H and D atoms formed in aqueous solutions by γ irradiation. A model, based upon three assumptions, is proposed to describe this anomalous behavior. Some justification for the assumptions is provided. In the development of the model, fairly simple explicit expressions are given for the field dependent spin eigenvectors for an electron interacting with a nuclear spin I in an arbitrary magnetic field. (auth)

159 ANALYSIS OF THE INTERNAL ROTATION OF THE CF_2CONH_2 RADICAL AS OBSERVED BY ESR IN IRRADIATED TRIFLUOROACETAMIDE SINGLE CRYSTALS. Bogan, C. M.; Kispert, L. D. (Univ. of Alabama, University). J. Chem. Phys.; 57: No. 8, 3109-20(15 Oct 1972).

The temperature-dependent ESR spectrum of the $\cdot CF_2CONH_2$ radical (found in x-irradiated single crystals of trifluoroacetamide) was measured at both 9 and 35 GHz over the temperature range from 77 to 290°K. A model is proposed, which explains the observed temperature dependence in terms of a torsional oscillatory motion about the C–C bond with a barrier height, V_0 = 3100 cal. Nonadiabatic spin exchange is used to account for the doublet splitting of the central line at 77°K changing to a single sharp line at all angles at 290°K. The exchange rate is described by the empirical equations $\tau^{-1} = 3.6 \times 10^8 \exp(-410 \text{ cal/RT})$. (auth)

160 STRENGTH OF ORIENTED POLYETHYLENE WITH A POLY(ACRYLONITRILE) GRAFT. Kurilenko, A. I.; Kalinin, V. N. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR; 16: No. 8, 715-18(Aug 1972). (In Russian).

The effect of a poly(acrylonitrile) (PAN) graft on the strength of oriented polyethylene (PE) was studied. A dose of 1.5 MR of γ rays (source not specified) was used to effect grafting with acrylonitrile vapors. The strength of the PE film was measured at the temperature of liquid nitrogen (–196°C) by subjecting the film to oriented stretching both before and after grafting. These tests showed that the breaking force did not depend on the extent of stretching nor on the quantity of grafted PAN. (K.S.W.)

161 UNSTABLE INTERMEDIATES. Pt. 117. ELECTRON SPIN RESONANCE STUDIES OF DIMERIC (sigma*) RADICALS OF TYPE $R_3X–XR_3$ WITH A THREE ELECTRON X–X BOND WHEN X IS PHOSPHORUS OR ARSENIC. Lyons, A. R.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 9, 1589-94(1972).

Seven hyperfine components separated by about 450 G were observed in the ESR spectrum of γ-irradiated triethylarsine at 77°K. This is indicative of two equivalent interacting arsenic atoms, and an analysis of the hyperfine tensor components suggests that the species is the dimer cation $(R_3As–AsR_3)^+$ with a σ^2, σ^{*1} structure as in V_K centers. Similar species are formed in γ-irradiated trialkyl phosphines, but are not formed from phosphonium or arsonium salts, nor from the phosphines or arsines in methanol glasses. Irradiation of $Me_2PS–PSMe_2$ gave a similar di-phosphorus radical. The magnitudes of the derived orbital populations for phosphorus or arsenic suggest that, although some flattening of the local pyramidal character of the R_3M groups occurs, this is far less than that observed for the monomeric R_3M^+ radicals. (auth)

162 CORRELATION OF SPECTRAL DATA FOR HALOGEN ATOM COMPLEXES WITH THE ELECTRON DONORS INVOLVED. Buehler, Rolf E. (Swiss Federal Inst. of Tech., Zurich). J. Phys. Chem.; 76: No. 22, 3220-8(26 Oct 1972).

With known data from pulse radiolysis and photolysis for transient charge-transfer complexes (CT complexes) with chlorine, bromine, and iodine atoms, the correlation of the CT energy (E_{CT}) with the ionization potential, I_D, of the electron donors was studied. It is shown that the pseudolinear dependency with slopes much less than one can be explained by the nonlinear, general solution for the simple resonance structure model $E_{CT} = (\gamma_0 I_D^2 - \gamma_1 I_D + \gamma_2)^{\frac{1}{2}}$. With an estimated value for the overlap integral S_{01} this correlation can be fitted to experimental data by the least-squares method, which then permits calculation of the resonance integral β_0 and an energy term C_1, which contains the electron affinity. From these three values (S_{01}, β_0, and C_1) I_D dependency of characteristic data for the ground state and excited state of the complexes can be derived. The resonance energies, the enthalpy of formation, the ionic character, and the dipole moments show strong dependences on I_D, but the derived transition moments, the oscillator strengths, and the extinction coefficients ϵ_{max} have little correlation with I_D. The calculated ϵ_{max} is compared to experimental values. The rather small differences are most likely due to the neglected environmental and structural effects. (auth)

163 FURTHER STUDIES OF CHEMICAL REACTIONS ON γ-IRRADIATED SILICA GEL AND POROUS VYCOR GLASS. Joppien, G. R.; Willard, J. E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 76: No. 22, 3158-66(26 Oct 1972).

Energy deposited in either silica gel or porous Vycor glass by γ-irradiation can activate adsorbed CH_3Cl, C_2H_5Cl, C_3H_7Cl, C_2H_4, C_2D_4, C_3H_6, and CH_4 with approximately equal effectiveness (G (products) = ca. 1 in each case). The products include CH_4 and C_2H_6 from CH_3Cl at 77 and 300°K, C_2H_6 and C_4H_{10} from C_2H_4 at 77 and 300°K, CH_3 radicals from CH_4 at 77°K, C_2D_4H radicals from C_2D_4 at 77°K, and peroxy radicals from $O_2–CH_3Cl$ and $O_2–CH_4$ mixtures at 77°K. When CH_3Cl and C_2H_4 are present together on the surface they compete for activation by energy absorbed in the gel. O_2 admitted to CH_3 radicals trapped on silica gel at 77°K converts them slowly to peroxy radicals. Sorbed CH_3 radicals exposed to C_2H_4 at 77°K yield propane on analysis at room temperature. Yields of stable products from radiolyses of sorbates on the gel decrease sharply for doses above 4×10^{18} eV g^{-1} at 77°K, but not at 300°K, suggesting a preempting of most of the sensitive energy transfer sites by products at the lower temperature, but release of the sites by desorption at the higher temperature. The influence of gel preparation and sorbate concentration on G values and the effect on the ESR spectra of sorbed radicals are illustrated. (auth)

164 ANNEALING AND OTHER VARIABLES WHICH AFFECT OBSERVED DECAY RATES OF TRAPPED ELECTRONS IN 3-METHYLPENTANE GLASS. Shooter, David; Willard, John E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 76: No. 22, 3167-71(26 Oct 1972).

The rate of decay at 77°K of trapped electrons produced by γ-irradiation of 3-methylpentane (3MP) glass decreased with time of annealing of the matrix at 77°K before γ-irradiation, and, for short annealing times, was dependent on the geometry of the sample. In quench cooled samples in 2-mm i.d. tubes the initial half-life increased from 10 min without annealing to 60 min for samples annealed for 250 hr, but there was little or no effect of annealing on the yields and absorption spectra of the trapped electrons. Decay rates measured by ESR and ir were compared and sources of error in both types of measurement considered. (auth)

165 ELECTRON SPIN RESONANCE STUDY OF γ-IRRADIATED SINGLE CRYSTALS OF AMMONIUM OXALATE MONOHYDRATE. Premovic, P. I.; Adamic, K. J.; Herak, J. N. (Boris Kidric Inst., Vinca, Yugoslavia) J. Phys. Chem.; 76: No. 22, 3274-8(26 Oct 1972).

Free radicals produced in a single crystal of ammonium oxalate monohydrate by γ irradiation were investigated with the method of electron spin resonance. At 77°K three different species are found: B, $O_2^-CCO_2$; C, $[HOOCCO_2^-]\cdot^-$; and radical pairs (D). The spin-spin interaction comes from the different radicals B and C. On heating, the radical pairs vanish first. At temperatures above 190°K concentration of species C decays. At room temperature, two radical species are detected: A, $O_2^-CCOH^-$, and B. Radicals denoted as A are more stable than species B. (auth)

166 IONIZATION CURRENT MEASUREMENTS IN GASES USING AN INTERNAL TRITIUM β SOURCE. Cooper, R.; Mooring, R.-M. (Univ. of Melbourne). Aust. J. Chem.; 25: No. 10, 2125-32(Oct 1972).

Beta particles from tritium were used as an energy source for the ionization of gaseous xenon, argon, neon, and oxygen. The ion currents determined from an ionization chamber study of T_2–gas mixtures enable the energy required to form an ion pair

(W value) to be calculated for these gases. A series of fluorocarbon gases were studied and their W values determined for the first time. Consideration of the energy transfer (Jesse) effect limits the usefulness of this technique to gases of ionization potential of less than 15.5 eV. (auth)

167 REACTIONS OF THE ACETONE CATION. IMPLICATIONS FOR THE RADIOLYSIS OF ACETONE. Sieck, L. W.; Ausloos, P. (National Bureau of Standards, Washington, D. C.). Radiat. Res.; 52: No. 1, 47-58(Oct 1972).

The reactions of the acetone and acetyl cation with acetone were investigated in a photoionization mass spectrometer. Reaction of the acetone cation with ≦0.3 eV internal energy occurs essentially at every collision ($k = 8.4 \times 10^{-10}$ ml/molecule sec), but decreases slightly with an increase in internal energy. Two reaction channels are observed for the acetone cation: (a) $CH_3COCH_3^+ + CH_3COCH_3 \rightarrow (CH_3)_2COH^+ + CH_3COCH_2$ and (b) $CHCOCH_3^+ + CH_3COCH_3 \rightarrow CH_3COCH_3COCH_3^+ + CH_3$. The CH_3CO^+ ion reacts mainly as follows: $CH_3CO^+ + CH_3COCH_3 \rightarrow CH_3 \cdot COCH_3COCH_3^+$ ($k \cong 4.6 \times 10^{-10}$ ml/molecule sec). At pressures above 10^{-3} Torr $(CH_3)_2COH^+$ and $CH_3COCH_3COCH_3^+$ reacts further with acetone to produce $(CH_3CO\text{-}CH_3)_nH^+$. It is suggested that in liquid phase radiolysis experiments the acetone cation will react within 10^{-12} to 10^{-13} sec. Recent radiolysis experiments in which acetone was used as a solvent are discussed in the light of this premise. (auth)

168 RADIATION CHEMISTRY OF TRITIUM BETA PARTICLES. Gagnon, William Frederick. New Brunswick, N. J.; Rutgers–The State Univ. (1972). 82p. University Microfilms Order No. 72-27,552.

Thesis.

The pattern of energy deposition by beta particles in aqueous media was previously thought to be essentially identical to that of high energy electromagnetic radiation (gamma or x rays), being pictured as a series of isolated spherical regions of ionization ("spurs"). In contrast, radiations of higher specific ionization (e.g., alpha particles) deposit energy in dense tracks throughout their range. Recent theoretical studies indicated that low-energy beta particles, like those from tritium, might deposit their energy in a spatial distribution somewhere between these two extremes. On this basis, radiation chemical changes and, by extension, radiation biological effects brought about by tritium beta particles might be expected to show some differences from the well-studied effects of gamma or x rays. Experiments designed to test this conclusion were performed. Effects of free-radical scavenging on the radiolytic yields (G values) of aqueous solutions were compared with similar solutions using gamma rays and indeed marked differences were observed. The implications of the results on the understanding of radiobiological effects and environmental impact of tritium betas are discussed. (Diss. Abstr. Int., B)

169 RADIOLYSIS OF NITROBENZENE. Knight, J. A. (Georgia Inst. of Tech., Atlanta). Radiat. Res.; 52: No. 1, 17-24 (Oct 1972). (ORO–3519-9).

Radiolysis of nitrobenzene shows that most of the radiolytic products can be related structurally to the parent molecule. Of the gaseous products, nitrogen is the most important. Other gaseous products are hydrogen, nitric oxide, carbon monoxide, and carbon dioxide. Major products are phenol, nitrosobenzene, and the isomeric nitrobiphenyls. Lesser products are benzene, biphenyl, the isomeric dinitrobenzenes, and the isomeric dinitrobiphenyls. The effects of the additives, diphenylpicrylhydrazyl, galvinoxyl, and sulfur hexafluoride, on the yields of nitrogen, nitric oxide, hydrogen, nitrosobenzene, and phenol were determined. The results with the additives are complicated and do not lend themselves to a simple interpretation. (auth)

170 TRANSIENT SPECIES IN THE REACTIONS OF SOME PYRIDYL COMPLEX IONS WITH HYDRATED ELECTRONS. Baxendale, J. H.; Fiti, M. (Univ. of Manchester, Eng.). J. Chem. Soc., Dalton Trans.; No. 18, 1995-8(1972).

The reactions of e^-_{aq} with $Co(bipy)_3^{3+}$, $Ru(bipy)_3^{3+}$, and $Co(terpy)_2^{3+}$ give transient species whose reactivities are consistent with the view that they are radical anions of the pyridyl ligands. (auth)

171 RADIOLYSIS OF BARIUM AZIDE. Prout, E. G.; Sears, W. G. (Univ. of Cape Town). Inorg. Nucl. Chem. Lett.; 8: No. 11, 937-42(Nov 1972).

The decomposition of anhydrous and dehydrated barium azide by x rays was studied and compared with that of lithium and sodium azides. Pressure-time plots are shown for the radiolysis at 0°C of whole and ground anhydrous crystals and for the dehydrated monohydrate; these were linear over long periods of time, but mechanical damage rendered the solid more sensitive to the x rays. The degree of reproducibility of radiolysis of single crystals of the anhydrous azide was very high. Activation energies were evaluated for the radiolysis of both whole and ground crystals, and are shown tabulated. The main study was carried out with the ground dehydrated azide on account of its greater radiolytic rate, and the effect of various grinding times was investigated. In order to determine the penetration of the x rays, pellets of various masses were decomposed. The rate of decomposition increased up to a mass of 500 mg, but thereafter remained constant. The rate of radiolytic decomposition was found to be directly proportional to the first power of the intensity of the x rays in the temperature range +2 to −120°C. A definite sensitization of the salt occurred with age, a specimen stored for one year decomposing 2.5 times faster than the fresh specimen. Throughout the temperature range +50 to −102°C the pellets were deeply colored after radiolysis, ranging from brown-grey at high temperatures to dark green at low temperatures. The effects of water and mercury vapor on the radiolysis were investigated. The radiolysis mechanism of barium azide between 0 and 50°C resembled that of lithium and sodium azides in the temperature range −18 to +15°C, but the low activation energy between −37 and −102°C suggested a different mechanism. (UK)

172 EFFECT OF CRYSTAL STRUCTURE ON THE STABILITY, YIELD, AND SHAPE OF ESR SPECTRA OF GAMMA-IR-RADIATED AMINO ACIDS AND DIPEPTIDES. Kushelevsky, A. P.; Slifkin, M. A. (Univ. of Salford, Eng.). Radiat. Eff.; 15: No. 3-4, 175-81(Aug 1972).

The electron spin resonance spectra of some irradiated aliphatic amino acids and dipeptides were observed and quantitative measurement obtained of their free radical yields. The yields, ESR spectra, and stabilities are explained in terms of their crystal structure. (auth)

173 RADIOLYSIS OF LITHIUM AND SODIUM AZIDES. Prout, E. G.; Sears, W. G. (Univ. of Cape Town). Inorg. Nucl. Chem. Lett.; 8: No. 11, 943-7(Nov 1972).

A study was made of the x-ray radiolysis of these azides, with a view to determining activation energies, using the conventional kinetic approach of following the rate of gas evolution in a high-vacuum system. Reproducible results were obtained with the lithium salt only if pellets were used, but NaN_3 crystals gave reproducibility. Pressure-time plots were linear, even after 20 hours' continuous irradiation at 0°C. Both azides were almost completely transparent to the x rays. The activation energies and the dependence of the radiolytic rates on the intensity of the irradiation were used in formulating reaction mechanisms. The rate of evolution of N_2 was directly proportional to the first power of the intensity. The lithium salt was light blue at room temperature and deep purple at −25°C after radiolysis, while the sodium salt was deep yellow at all temperatures. Increased pelleting pressure and grinding accelerated the rate of radiolysis of LiN_3. Pre-irradiation of the salt with uv depressed the rate of subsequent radiolysis of both salts, probably owing to the screening effect of photolysis products. Mechanisms are discussed, and the concept of the irradiation creating positive holes rather than excitons or excited azide ions is favored. The value of the activation energy was placed at 3.8 kcal/mol in the temperature range −35° to +15°C. The existence of color centers suggested that the electrons do not pass into the conduction band but are trapped to form color centers. The protracted nature of the radiolysis indicates a large reservoir of traps for the positive holes. Sodium is probably formed by the reaction $Na^+ + e \rightarrow Na$. (UK)

174 CAPTURE AND RECOMBINATION REACTIONS OF ELECTRONS IN LIQUID CYCLOHEXANE. Yakovlev, B. S.; Boriev, I. A.; Novikova, L. I.; Frankevich, E. L. (Inst. of Physical Chemistry, Moscow). Int. J. Radiat. Phys. Chem.; 4: No. 4, 395-404(Oct 1972). (In Russian).

The electron-pulse-induced conductivity of aromatic hydrocarbon solutions in cyclohexane and its dependence on concentration and time were investigated. A current I_e due to the electron conductivity was revealed at a concentration of solute [A] less than 10^{-5} mol dm^{-3}. The dependence of I_e on [A] and known values of electron and ion mobilities in cyclohexane lead to rate constants for electron capture by A of $(2.1 \pm 0.4) \times 10^{12}$ and $(2.3 \pm 0.4) \times 10^{12}$ dm^3 mol^{-1} s^{-1} for pyrene and diphenyl respectively. The electron and positive ion recombination rate constants are shown to be close to theoretical values for diffusion-controlled recombination. (auth)

175 UNSTABLE INTERMEDIATES. Pt. 116. RADICAL ANIONS ON N-HALOGENATED AMIDES. Neilson, G. W.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 9, 1582-8(1972).

Exposure to γ radiation of powdered or single crystal samples of N-chloro- and N-bromosuccinimide, and of N-bromoacetamide, at 77°K gave paramagnetic species whose ESR spectra were characteristic of radicals having an unpaired electron predominantly

in a N-Hal σ^* orbital, almost equally distributed between the nitrogen and halogen atoms. These radicals are, therefore, identified as the radical anions of the amides. Alternative structures are considered and these anions are contrasted with those derived from corresponding carbonyl compounds. (auth)

176 EFFECTS OF INTERNAL MONOMER CONCENTRATION AND DEGREE OF SWELLING ON GRAFT POLYMERIZATION OF ACRYLONITRILE ONTO POLY(VINYL CHLORIDE) FIBER. Hashimoto, Shoji; Udagawa, Akira; Kusama, Yasuo; Shimada, Machiko; Kageyama, Eiichi (Japan Atomic Energy Research Inst., Takasaki). Nippon Kagaku Kaishi; No. 8, 1508-14 (Aug 1972). (In Japanese).

Radioinduced graft copolymerization of acrylonitrile on poly (vinyl chloride) fiber was investigated. The effect of the degree of swelling of the fiber and monomer concentration in the fiber on grafting was studied. When the acrylonitrile monomer was applied as solution in n-hexane, n-heptane, or cyclohexane, a maximum and a minimum of grafting was observed as the monomer concentration in the solution was increased. But such phenomena were not observed in ethyl acetate solution. In order to understand such effect, several experiments were carried out, and it was concluded that a reasonable explanation can be given assuming the following two relationships: at constant degree of swelling, the grafting rate increased with the increase of monomer concentration in the fiber and at constant monomer concentration in the fiber, the grafting rate decreased with the increase of degree of swelling. (auth)

177 RADICAL FORMATION OF THYMINE STRUCTURE DURING RADIOLYSIS OF FROZEN ALKALI THYMINE SOLUTIONS. Sharpatyi, V. A.; Sultankhodzhaeva, M. N.; Rakhmanov, A. S. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 203: No. 5, 1126-8(11 Apr 1972). (In Russian).

The mechanism of formation of radicals of thymine structure in DNA solutions was studied by the radiolysis of thymine in vitrified alkaline (10 M KOH) solutions at 77°K. Radiation doses of 1.5 MR yielded spectra with hyperfine structure doublets; doses of 7 to 13 MR yielded, besides the doublets, an eight-component line of thymine structure. Various conditions, such as the influence of light of $\lambda \geq 300$ mμ, caused the thymine radical to be converted to thymine structure. (K.S.W.)

178 IMPORTANCE OF ELECTRONIC EXCITED STATES IN THE GAMMA RADIOLYSIS OF ORGANIC LIQUIDS. DETERMINATION OF THE NUMBER OF EXCITED SINGLETS AND TRIPLETS PRODUCED IN THE GAMMA IRRADIATION OF BENZENE. Zarnegar, Bizhan Mohammed. Chapel Hill, N. C.; Univ. of North Carolina (1972). 113p. University Microfilms Order No. 72-24,865.

Thesis.

The technique of energy transfer to a reactive solute was used to estimate yields of radiolytically produced excited states in the gamma irradiation of benzene. The radiolytic cis-trans isomerization of stilbene and several nitrogen analogs of stilbene were investigated. The dominance of excited-state processes in the radiolysis was determined using the criterion of near identity of the radiostationary and benzophenone-sensitized photostationary states. Azulene quenching of stilbene isomerization in gamma-irradiated benzene solutions was not linear. This indicated the intermediacy of more than one state leading to the isomerization. Thus, stilbene is not a suitable candidate, as previously assumed, to specifically measure the yield of excited triplet benzene molecules. A nitrogen analog of stilbene, 1,2-bis(2-pyridyl)ethylene, was previously found to isomerize efficiently only from its excited triplet state. Using the isomerization of this olefin, $G(^3B_{1u}) = 4.4$ was obtained for the radiolytic yield of triplets produced by paths bypassing the lowest singlet of benzene. Results suggest that even up to concentrations of 0.5 M, solute triplets are produced almost exclusively via energy transfer from the benzene triplet. A study of the radiolytic "type II" elimination of 4-methyl-4-phenyl-2-pentanone (MPP) was undertaken. γ-Radiolysis of MPP in benzene solution or in pure ketone leads to the type II process to yield α-methylstyrene and acetone as the only major decomposition pathway. Quenching studies with biacetyl indicated that all of the radiolytic type II process in benzene solution and possibly 60% in pure MPP arise from the MPP excited singlet. Kinetic analysis revealed that two processes lead to production of singlet MPP in dilute (<0.1M) benzene solutions; one is energy transfer from the benzene lowest excited singlet. A value of $G(^1B_{2u}) = 1.4$ was obtained from the concentration dependence of the reaction yield. The origin of the second source of MPP singlets in benzene is uncertain; one possibility is energy transfer from a higher singlet of benzene. The yield of excited singlet in MPP in pure ketone was estimated to be G = 5, a value considerably higher than the singlet yield in liquid benzene. (Diss. Abstr. Int., B)

179 KETYL RADICALS OF BENZOYLPYRIDINES. Nelson, D. A.; Hayon, E. (Army Natick Labs., Mass.). J. Phys. Chem.; 76: No. 22, 3200-7(26 Oct 1972).

The absorption spectra, extinction coefficients, decay kinetics, and dissociation constants of the ketyl radicals and the radical anions of 2-, 3-, and 4-benzoylpyridines were observed and determined. These radicals were produced from reactions with hydrated electrons in aqueous 1.0 M tert-butyl alcohol, using the technique of pulse radiolysis. The ketyl radicals have high extinction coefficients and absorption bands in the visible and uv regions. The pK_a's are 12.3 ± 0.2, 9.2 ± 0.2, and 12.0 ± 0.2 for 2-, 3-, and 4-benzoylpyridine, respectively. A second dissociation constant of the ketyl radicals for the corresponding benzoylpyridinium ions was observed with pK_a's of 3.1 ± 0.1, 4.1 ± 0.2, and 4.2 ± 0.2, respectively. Identical spectra were observed from the reaction of acetone ketyl radicals $(CH_3)_2\dot{C}OH$ with these benzoylpyridines (BP), indicating a quantitative electron transfer to form the corresponding ketyl radicals. The rate constants of reactions of $(CH_3)_2\dot{C}OH$ radicals with BP were found to be dependent on the pK_a of the BP. The ketyl radical and radical anions of 3-benzoyl-N-methylpyridinium ion were found to be distinctly different from those of 3-BP and a $pK_a = 5.9 \pm 0.2$ was determined. The absorption spectra of the H atom adducts to benzoylpyridinium ions were also determined and are compared with those of the ketyl radicals. Analogies between the photochemistry and radiation chemistry of benzoylpyridines and benzophenone are discussed. (auth)

180 GENERAL REVIEW AND SURVEY OF GAS-TO-PARTICLE CONVERSIONS. Mohnen, V. A.; Lodge, J. P. Jr. pp 69-91 of Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990.

The review is presented according to basic processes responsible for gas-to-particle conversions. They are: condensation, chemical interaction in the gas phase, combustion, photolysis, electric discharge chemistry, radiolysis, and ice crystal formation. (123 references.) (J.G.B.)

181 FORMATION AND EVOLUTION OF RADIOLYSIS PARTICLES. Billard, F.; Bricard, J.; Madelaine, G. J.; Clerc, N. pp 169-72 of Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990.

The effects of ionizing radiation on a dust-free atmosphere, a dust-free atmosphere partially rid of its gaseous impurities, and an ordinary atmosphere were studied. The number of particles formed increases with an increase in radiation dose and concentration of gaseous impurities, such as SO_2. (J.G.B.)

182 RADIATION GRAFTING TO CELLULOSIC FIBERS. Sakurada, I. (Japan Atomic Energy Research Inst., Osaka). Chem. Technol.; 376-81(Jun 1972).

Some fundamental problems of radioinduced grafting of vinyl monomers on cellulosic fibers are discussed. In most cases styrene was used for grafting on cellulose. Degradation of cellulose by irradiation, radiation effects on tensile properties of the cellulose fibers, mechanical properties of grafted fibers, and true and apparent graft are discussed. (M.C.G.)

Radiochemistry and Nuclear Chemistry

Refer also to abstract 97.

183 (HMI-B-124) NUCLEAR CHEMISTRY DIVISION AND REACTOR DIVISION ANNUAL RESEARCH REPORT, 1971. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Jul 1972. 42p. Dep. NTIS (U. S. Sales Only).

Abstracts of papers published in 1971 and a cumulative list of publications from 1968 through 1971 are presented. Topics covered include: radionuclides, trace elements in ecosystems, solid-state problems in reactor chemistry and waste processing, and neutron scattering. (M.C.G.)

184 NUCLEAR MILESTONES. A Collection of Speeches. Seaborg, Glenn T. San Francisco; W. H. Freeman and Company (1972). 397p. $7.50.

Part I, Builders and Discoverers, consists of reflections dealing with pioneers of the nuclear age and presented mostly through words spoken at celebrations of anniversaries and

other events during the author's tenure as Chairman of the U. S. Atomic Energy Commission. Part II, Historic Landmarks, focuses on the institutions in which the great discoveries of nuclear science were made and advanced. The book is bountifully illustrated. (J.G.B.)

Hot-Atom Chemistry

185 (COO-1629-7) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $^{14}N(n,p)^{14}C$ IN VARIOUS NITROGENOUS COMPOUNDS. Final Report, May 1, 1966–September 30, 1972. Vaughan, John D. (Colorado State Univ., Fort Collins. Dept. of Chemistry). 15 Sep 1972. Contract AT(11-1)-1620. 54p. Dep. NTIS.

The identities and relative amounts of labeled products resulting from the nuclear transformation $^{14}N(n,p)^{14}C$ were studied in alkali metal azides and tetrazole. Kinetics of deuteration of five-member aromatic heterocycles are discussed. (M.C.G.)

186 (ORO-3898-13) REACTIONS OF HIGH-ENERGY RADIOACTIVE ATOMS RESULTING FROM NUCLEAR TRANSFORMATIONS IN THE SYSTEMS OF SILICON-CONTAINING COMPOUNDS. Progress Report, February 1972–January 1973. Tang, Y. (Texas Agricultural and Mechanical Univ., College Station. Research Foundation). 1972. Contract AT(40-1)-3898. 57p. Dep. NTIS.

Research progress on reactions of recoil tritium and halogens with silanes, reactions of recoil ^{31}Si, reactions of recoil phosphorus, and energetics of hot atom reactions is reported in abstracts of papers published on the project. (M.C.G.)

187 EFFECT OF ELECTRON ACCEPTORS ON STABILIZATION Fe^{3+} IN GLASSES AFTER ^{57}Co DECAY. Kulikov, L. A.; Bugaenko, L. T.; Perfil'ev, Yu. D.; Babeshkin, A. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 347-8(1972). (In Russian).

The types of iron stabilization that arise in frozen aqueous solutions after ^{57}Co decay were studied. The yield of Fe^{3+} increased with electron acceptor concentration growth. (auth)

188 REACTIONS OF HOT (n,γ)-PRODUCED ^{80}Br WITH CH_3Br. COMPARISON WITH THE REACTIONS BETWEEN HOT ^{38}Cl AND CN_3Cl, AND CALCULATION OF THE EXCITATION FUNCTIONS. Alfassi, Zeev B.; Amiel, Saadia; Baer, Michael (Soreq Nuclear Research Centre, Yavne, Israel). J. Chem. Phys.; 57, No. 8, 3519-27(15 Oct 1972).

The reactions of hot (n,γ)-produced 17.6 m ^{80}Br with methyl bromide were studied in the presence of He and Kr as moderators. The survival probability of the reaction products was found to be the same in both moderators, suggesting that no observable decomposition took place upon moderation (within a 15% error). The reactivity integral for halogen displacement in the reaction was found to be equal to that in the system $^{38}Cl + CH_3Cl$, which seems reasonable since the activation energies and steric factors are almost equal. The ratio of hydrogen displacement to halogen displacement was smaller in the case of ^{80}Br than in that of ^{38}Cl, as can be predicted on the basis of the translational inertial factor. From the reactivity integrals and the activation energies the excitation functions for halogen displacement were calculated by the energy-dependent hard potential model of Baer and Amiel. (auth)

189 CLASSICAL DYNAMICS OF THE REACTION OF FLUORINE ATOMS WITH HYDROGEN MOLECULES. III. THE HOT-ATOM REACTIONS OF ^{18}F WITH HD. Muckerman, James T. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 57: No. 8, 3388-96(15 Oct 1972).

Excitation functions for the various product channels in reactions of hot ^{18}F atoms with ground-state HD are calculated using the Monte Carlo quasiclassical trajectory technique and an optimized semiempirical potential energy surface. The production of $H^{18}F$ and $D^{18}F$ and dissociation into $^{18}F + H + D$ are reported as a function of the center-of-mass collision energy over the range 0.1 to 65.0 eV. The calculated excitation functions for $H^{18}F$ and $D^{18}F$ cross at ~7 eV indicating an inversion in the intramolecular isotope effect with increasing collision energy. Features of these excitation functions and the calculated product energy distributions are discussed in terms of simple mechanistic models. The trajectory results, on the average, correlate well with the predictions of the spectator stripping model from epithermal collision energies up to the limiting energy where this model would lead only to dissociation. The high-energy tail of the abstraction excitation functions, however, is shown to be attributable to a mechanism which is the antithesis of spectator stripping. In these high-energy collisions, the nearer atom of the HD collides violently with the fluorine atom and recoils away. The training "abandoned atom" is left behind in the vicinity of the fluorine atom, with which it subsequently reacts. Information about a computer-animated film of trajectories selected from those calculated in this work illustrating these mechanistic interpretations will be supplied on request. (auth)

190 CHEMICAL KINETICS OF PHOTOCHEMICALLY PRODUCED HOT HYDROGEN ATOMS. Hong, Kong-yi. Detroit; Univ. of Detroit (1971). 81p. University Microfilms Order No. 72-20,804.

Thesis.

The reactions of hot hydrogen atoms in the range 0.9 to 1.8 eV with perdeuterated and partially deuterated compounds were studied. The hot atoms were produced in C_2D_6, C_3D_8, C_4D_{10}, SiD_4, Si_2D_6, CH_3CD_3, CHD_2-CHD_2, CD_3-H, and CH_3-SiD_3, by photolyzing $HI-RD-I_2$ and $HI-RHD-I_2$ mixtures. Plots of product ratios, H_2/HD, versus the initial reactant ratio, HI/RD, gives straight lines with zero intercept when RD are perdeuterated compounds and with positive intercepts when RD are partially deuterated compounds. The zero intercepts in perdeuterated compounds and $HI-I_2$ mixtures provides evidence for depression of scavenging reaction, i.e., $H + HI \rightarrow H_2 + I$, below detection level. The values of the positive intercepts are direct measurements of isotope effects for the photochemically produced hot H atom reactions. Numerically, slopes are equal to the average relative hot reaction rate constants for $H^* + HI \rightarrow H_2 + I$ and $H^* + RD \rightarrow HD + R$ reactions. Also, the hot H atoms were produced in $HI-RD$ (except SiD_4 and Si_2D_6) mixtures with I_2 excluded. The values of slopes and intercepts of the characteristic linear relationship for the plots of product ratio H_2/HD versus the initial reactants ratio HI/RD were obtained. The corresponding rate constant ratios measured in the I_2 included systems together with those from the I_2 excluded systems were used to estimate the average relative thermalized rate constants between HI and RD's. These estimated values suggest that the collisions between H^* and HI and RD's are inelastic ones. (Diss. Abstr. Int., B)

Properties of Radioactive Materials

Refer also to abstracts 1, 85, 100, 151, and 168.

191 (ORNL-4791, pp 104-6) CALORIMETRY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

POTASSIUM PERRHENATES—enthalpy of
TECHNETIUM OXIDES—preparation of Tc_2O_7 and TcO_3
(M.C.G.)

192 STUDY OF IONIC HYDRATION AND ITS VARIATION WITH TEMPERATURE. Satyavati, A. V. Curr. Sci. (India); 41: No. 20, 733(20 Oct 1972).

Determination of the hydration numbers is based on the measurement of adiabatic compressibility of solution at infinite dilution. Employing additive rule, cationic hydration numbers for Li^+, Rb^+, Ba^{2+}, Ca^+, Zn^{2+}, and Th^{4+} were evaluated. (M.C.G.)

193 MODERN STUDIES OF POLYNUCLEAR HETEROPOLY COMPLEXES. Spitsyn, V. I.; Torchenkova, E. A. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 259-69(1972). (In Russian).

Studies on polynuclear heteropoly complexes are surveyed. A method is suggested for isolation of heteropoly acids (HPA) with a general formula $H_8(M^{4+}Mo_{12}O_{42}) \cdot nH_2O(M^{4+} = Ce, Th, U)$ based on their low solubility in strong acid medium. HPA interaction with certain metal ions (Mn, Fe, Co, Ni, Cu, Zn, Cd, Y, Er, Yb, Th, Nb, Ta) was studied by spectrophotometry and by other methods. Introduction of metal ions into the inner sphere of HPA is proposed for the formation of polynuclear heteropoly complexes. (auth)

194 SPECTROPHOTOMETRIC INVESTIGATION OF ARSENAZO-III COMPLEXES. Mohai, M.; Upor, E. (Mecsek Ore Mining Enterprise, Pecs, Hungary). pp 55-60 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844(Vol.1).

Stable complexes formed by color reactions of metal ions (including Ca^{2+}, Zr^{4+}, Th^{4+}, Sc^{3+}, U^{6+}, Ti^{4+}, Al^{3+}, Fe^{2+}, Fe^{3+}, Cu^{2+}, Zn^{2+}, Ni^{2+}, Co^{2+}, Mn^{2+}, Ge^{4+}, Mo^{6+}, V^{5+}, Sn^{4+}, V^{4+}, and Pd^{2+}) with Arsenazo III were studied at pH 2.5. Masking effects of sodium hexametaphosphate on the reactions were investigated. The distribution of rare earths between lactato and Arsenazo complexes is given. It was found that both Zr(IV) and Hf(IV) form 1:1 complexes with Arsenazo III when oxalate is used as an auxiliary ligand. (J.G.B.)

195 STABILITY CONSTANTS OF 5,5'-THIO-DISALICYLIC ACID WITH SOME METAL IONS. Kumar, A. N.; Srivastava.

P. C.; Nigam, H. L. (Univ. of Allahabad, India). Indian J. Chem.; 9: No. 5, 488-9(May 1971).

The stability constants of titanium(III), manganese(II), iron(III), cobalt(II), nickel(II), copper(II), zinc(II), palladium(II), zirconium(IV), mercury(II), lead(II), thorium(IV), and uranyl(II) complexes with 5,5′-thiodisalicylic acid were determined potentiometrically. The order of stability for divalent, trivalent and tetravalent metal complexes investigated is as follows: $UO_2^{2+} > Pd^{2+} > Cu^{2+} > Ni^{2+} > Co^{2+} > Zn^{2+} > Pb^{2+} > Mn^{2+} > Hg^{2+} > Fe^{3+} > Ti^{3+}$ and $Th^{4+} > Zr^{4+}$. (auth)

196 CHELATES OF QUINALIZARIN WITH Cr(VI), Mo(VI), W(VI), AND U(VI). Rani, Sunita; Banerji, Samir K. (Birla Inst. of Tech. and Science, Pilani, India). Indian J. Chem.; 9: No. 5, 495-6(May 1971).

Quinalizarin forms colored complexes with Cr(VI), Mo(VI), W(VI), and U(VI) in 50% ethanolic medium. Molybdenum and uranium form 1 · 1 complexes with λ_{max} at 520 and 630 nm respectively, whereas chromium and tungsten form 1 : 2 complexes with λ_{max} at 520 and 510 nm, respectively. The composition, stability constants, and thermodynamic functions such as ΔG, ΔH and ΔS were determined. (auth)

197 REACTIVITY OF ALIPHATIC ALCOHOLS IN THE PHOTOREDUCTION OF URANYL SALT. Venkatraman, R.; Rao, S. Brahmaji (Sri Venkateswara Univ., Tirupati, India). Indian J. Chem.; 9: No. 5, 500-1(May 1971).

The reactivity of methyl, ethyl, isopropyl, n-butyl, t-butyl, and isobutyl alcohols in the photoreduction of uranyl ions was studied spectrophotometrically at 670 nm. The reduction rate follows the order: t-butyl < methyl < ethyl < isobutyl = n-butyl < isopropyl. The reactivity decreases with increase in the number of C−H bonds alpha to the hydroxyl group rather than with the decrease in the size of the molecule. The reactivity is well correlated by the $\Sigma\sigma^*$ value for α_{C-H} bond computed additively from the individual Taft's σ^* values for the alkyl groups. The mechanism is found to be similar to that proposed by Bowen for photodecomposition of dichromate ions or by Wells for photoexcited quinones. (auth)

198 ANISOTROPY OF LONG-WAVE INFRARED ABSORPTION OF URANYL NITRATE CRYSTALS. Volod'ko, L. V.; Komyak, A. I.; Serafimovich, A. I. Zh. Prikl. Spektrosk.; 17: No. 1, 122-5(Jul 1972). (In Russian).

The anisotropy of long-wave infrared absorption of uranyl trinitrate crystals ($RbUO_2(NO_3)$ and $KUO_2(NO_3)_3$) was studied in the region 200 to 300 cm^{-1}. An orientation of dipole moments for transition was established for bands in that region. The assignment of frequencies in this portion of the spectrum was discussed. (tr-auth)

199 STABILITY CONSTANTS OF Mn^{2+} AND UO_2^{2+} COMPLEXES WITH SOME AMINO ACIDS. Sekhon, B. S.; Singh, P. P.; Chopra, S. L. (Punjab Agricultural Univ., Ludhiana, India). Indian J. Chem.; 9: No. 5, 485-7(May 1971).

Stability constants of complexes of Mn^{2+} and UO_2^{2+} with β-phenylalanine, DL-methionine, and L-leucine at 25 ± 0.1, 35 ± 0.1, and 45 ± 0.1°C (μ = 0.1M KCl) were determined potentiometrically. The values of log k_1 and log k_2 decreased with the rise in temperature in all cases. The values of free energy change (ΔF, ΔS) and enthalpy change (ΔH) were also determined. (auth)

200 CALCULATION OF VIBRATIONS FOR HALIDE COMPLEXES OF URANIUM OF THE $(UO_2X_4)^{2-}$ TYPE. Fang Tin K'eng; Kovrikov, A. B.; Komyak, A. I. Zh. Prikl. Spektrosk.; 17: No. 1, 126-31(Jul 1972). (In Russian).

The frequencies and forms of normal vibrations were calculated for the complexes $(UO_2Cl_4)^{2-}$ and $(UO_2Br_4)^{2-}$. A new assignment of frequencies and evaluation of force constants were made. Definitive matrices of force constants were obtained by sequential matching. Good agreement with experimental data was noted. (tr-auth)

201 SPECTROSCOPIC STUDY OF URANYL CYANATOACETATES. Shchelokov, R. N.; Krasilov, Yu. I.; Karasev, V. E.; Orlova, I. M. Zh. Prikl. Spektrosk.; 17: No. 2, 279-85(Aug 1972). (In Russian).

Infrared absorption and luminescence spectra of uranyl complex cyanoacetates revealed a close relationship of their fundamental parameters. Fundamental vibration frequencies and similar data were used to determine the probable structure of the complexes: the inner sphere consisted of hexa- and penta-coordinated centers connected by bridge acetate groups. (tr-auth)

202 COORDINATION CHEMISTRY OF URANIUM. 1. ETHER COMPLEXES OF URANIUM PENTACHLORIDE. Ortego, J. Dale; Tew, William P. (Lamar Univ., Beaumont, Tex.). J. Coord. Chem.; 2: No. 1, 13-21(Aug 1972).

Carbon disulfide solutions of uranium(V) chloride were found to react with simple cyclic and alkyl ethers to produce solid 1 : 1 adducts. In addition to tetrahydrofuran (THF) and 1,4-dioxane the donor molecules involved in the study included dimethyl, diethyl, diisopropyl, dibutyl, and diisopentyl ether. These new compounds were characterized by electronic and infrared spectroscopy, conductance, molecular weight, and magnetic susceptibility measurements. (auth)

203 HIGH-VOLTAGE ELECTROPHORESIS OF ^{106}Ru: SEA-WATER SYSTEMS. Ishikawa, M.; Pucar, Z. (Inst. Rudjer Boskovic, Zagreb). J. Radioanal. Chem.; 11: No. 2, 197-207(Aug 1972).

The physicochemical behavior of ^{106}Ru chloro and nitrosyl-nitrato complex species in seawater at pH 8 was investigated by high-voltage electrophoresis. The ^{106}Ru chloro complexes in the seawater system were separated into at least 10 anionic species, one "neutral" hydrolytic species, and 2 cationic species. The ^{106}Ru nitrosyl-nitrato complexes in seawater were separated into 3 anionic species, one "neutral" species, and 3 cationic species. The absolute electrophoretic mobilities of the separated ^{106}Ru species in seawater were found to be constant during the aging period from 48 to 1080 hrs. In the initial period up to 48 hrs of aging, considerable physico-chemical changes were observed for both the chloro and nitrosyl-nitrato forms of ^{106}Ru, as a result of the initial stabilization of the system. The aging of the systems up to 1080 hrs was followed quantitatively by radiometric counting of the separated soluble species. The significant decrease of the radioactivity of the soluble systems during the aging was found to be due to the precipitation of the ruthenium species. The results obtained are discussed with regard to the consequences that ^{106}Ru waste disposal in the sea may have on the marine environment. (auth)

204 POLYMERIC STRUCTURE OF THE URANYL OXYDIACETATO COMPLEX. Bombieri, G.; Forsellini, E.; Graziani, R.; Tomat, G.; Magon, L. (CNR, Padua). Inorg. Nucl. Chem. Lett.; 8: No. 11, 1003-7(Nov 1972).

Preparation and preliminary structural data are reported for the oxydiacetate dioxouranium(VI) compound. Aqueous solutions of uranyl nitrate and oxydiacetic acid were mixed and evaporated slowly, giving a powder precipitate. On treating this precipitate with water at room temperature in a sealed glass for two weeks crystals large enough for single crystal investigation were obtained. Analysis corresponded to the formula $UO_2O(CH_2COO)_2$. The crystals were pale yellow in color, prismatic or tetragonal. The structure was solved by the heavy atom method, but no attempts were made to determine the absolute configuration. The environment of the U atom is shown, together with the principal interatomic distances and angles, and the entire structure can be described in terms of a three-dimensional network of cross-linked U−ligand chains with screw symmetry. There were some noticeable analogies between the coordination mode in the solid state and in solution, and the polymeric structure found in the solid state can possibly be related to the observed tendency for the formation of polynuclear species in aqueous solutions. (UK)

205 REDUCTION OF FERMIUM TO DIVALENT STATE IN CHLORIDE AQUEOUS ETHANOLIC SOLUTIONS. Mikheev, N. B.; Spitsyn, V. I.; Kamenskaya, A. N.; (and others) (Inst. of Physical Chemistry, Moscow). Inorg. Nucl. Chem. Lett.; 8: No. 11, 929-36(Nov 1972).

In order to reduce Fm to the divalent state it is necessary to have a system with a high reduction potential. This was achieved in the simultaneous reduction of Sm and Fm chlorides by Mg metal in aqueous ethanolic solutions, the sparingly soluble $SmCl_2$ taking up Fm^{2+}. The true isomorphous cocrystallization that occurred made it possible both to identify and stabilize the divalent state of Fm, since Fm^{2+} formed a part of the matrix of the $SmCl_2$ crystal lattice. The Dubna 310-cm heavy ion cyclotron was used to obtain ^{252}Fm by the reaction $^{238}U(^{18}O,4n)^{252}Fm$. The extraction of Fm from the irradiated U_3O_8 was carried out with the help of Sm and Eu fluorides serving as Fm carriers. Details are given of the chemistry of the process, and the results are discussed. (UK)

206 CRYSTAL AND MOLECULAR STRUCTURE OF [NN'ETHYLENE-BIS(SALICYLIDENEIMINATO) UO_2 (MeOH)]. Bandoli, G.; Clemente, D. A.; Croatto, U.; Vidali, M.; Vigato, P. A. (Consiglio Nazionale delle Richerche, Padua). Inorg. Nucl. Chem. Lett.; 8: No. 11, 961-4(Nov 1972).

Preparation and structure are reported for the uranyl complex with a potentially tetradentate ligand: N,N′-ethylenebis(salicylideneimine), a condensed Schiff base already known to react with several first-row transition metals. The complex was obtained

by the reaction of $UO_2Cl_2 \cdot 3H_2O$ or $UO_2(NO_3)_2 \cdot 6H_2O$ with the Schiff base. An x-ray structural determination was carried out to determine the coordination number, to investigate the U–N bond with respect to U–O distances, and to compare the behavior of the ligand in this complex with analogous complexes of first-row transition metals. Results are given. (UK)

207 KINETICS AND MECHANISM OF THE FORMATION OF THE CHROMIUM(III)–URANIUM(V) BINUCLEAR COMPLEX. Ekstrom, A.; Farrar, Y. (Australian Atomic Energy Commission, Lucas Heights). Inorg. Chem.; 11: No. 11, 2610-15(Nov 1972).

The kinetics of the formation of the [Cr(III) · U(V)] binuclear complex were measured by stopped-flow techniques. The rate of formation of the complex was found to be given by the expression $d(complex)/dt = k[UO_2^{2+}][Cr^{2+}]$. The value of k is (1.29 ± 0.04) × 10^4 M^{-1} sec^{-1}, at 14.5° and an ionic strength of 2.0, and is independent of acid concentration in the range 0.03 to 2.0 M $[H^+]$. The reaction has an activation energy of 1.38 ± 0.40 kcal mol^{-1}, and mechanisms consistent with the observed data are discussed. (auth)

208 KINETICS OF THE REACTION BETWEEN THE CHROMIUM(III)–PLUTONIUM(V) COMPLEX AND PLUTONIUM(III) IN AQUEOUS PERCHLORATE SOLUTIONS. Lavallee, C.; Newton, T. W. (Los Alamos Scientific Lab., N. Mex.). Inorg. Chem.; 11: No. 11, 2616-20(Nov 1972).

The reaction Pu(III) + Cr(III) · Pu(V) = 2Pu(IV) + Cr(III) was studied in acid perchlorate solutions from 0.05 to 2.0 M $HClO_4$ and from 1.7 to 44.5°C. The rate law in 2 M $(H,Li)ClO_4$ solutions is $d[Pu(IV)]/dt = 2k'[Pu(III)][Cr(III) \cdot Pu(V)] \cdot [H^+]^0$. The rate constant k' is 122 M^{-1} sec^{-1} and the activation parameters are $\Delta F^* = 14.61$ kcal/mol, $\Delta H^* = 4.58 \pm 0.07$ kcal/mol, and $\Delta S^* = -33.6 \pm 0.2$ cal/(mol deg) at 25°C in 2 M $HClO_4$. Rates in $NaClO_4$ solutions are lower than in $LiClO_4$ solutions, apparently due to a medium effect. The ionic strength dependences up to 3.86 M $LiClO_4$ and up to 5.54 M $NaClO_4$ are consistent with the extended form of the Debye–Hückel equation with a distance of closest approach of 11 Å. A moderate, essentially linear $[Cl^-]$ dependence was found. The results are compared with the analogous reduction of uncomplexed Pu(V). (auth)

209 ADDUCT FORMATION OF URANYL–TTA CHELATE WITH NEUTRAL LIGAND. Akiba, K. (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 145-7(Dec 1970). (In Japanese).

Since bis(TTA)uranium has vacancies in its coordination seats, it is known that it forms adducts with neutral molecules that have lone pairs. Adduct formation in organic solutions was examined by means of the solubility method. The uranyl chelate labelled with ^{237}U was synthesized. By studying curves that indicate solubility change due to the variation of ligand (L) concentration, it was found that only the 1 : 1 adduct $UO_2A_2 \cdot L$ was formed, the higher order adduct $UO_2A_2 \cdot mL (m > 1)$ formation was not recognized. Alcohols and ketones, well-known solvents with oxygen, had considerable coordination capability. (Japan)

210 ADDUCT FORMATION OF URANYL–CHELATE WITH TPPO. Akiba, Kenichi (Tohoku Univ., Sendai); Kanno, Takuji; Wada, Mikio. Kakuriken Kenkyu Hokoku; 4: No. 1, 126-30(Sep 1971). (In Japanese).

Adduct formation of uranyl thenoyltrifluoroacetone (TTA) chelate with triphenylphosphine oxide (TPO) was examined. Distribution between two phases was studied using ^{237}U tracer. If the TPO coexists, the uranium distribution ratio between the organic solution containing TTA and TPO and the water phase, remains constant regardless of concentration in low uranyl concentration region, but decreases as the concentration increases. Further, the distribution ratio between the TTA solution without TPO content and the water phase was determined. By examining the adduct formation constant, effects of solvent similar to those for TBP adduct are also suggested for the TPO adduct. (Japan)

211 THERMAL DECOMPOSITION OF PLUTONIUM HEXAFLUORIDE. Tsujimura, Shigeo; Hirano, Kenmei; Takahashi, Akira; Fujisawa, Ginji (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 534-7(Sep 1972).

The thermal decomposition of PuF_6 in the temperature range from 100 to 160°C was studied. At 100 and 120°C, no decomposition was detected. At 140 and 160°C, the rate of decomposition during reaction lasting up to 20 hr, and the dependence of the decomposition on the initial PuF_6 pressure were determined. The results are explained by assuming that the rate of decomposition is proportional to the 0.4-th power of PuF_6 pressure. The activation energy of the reaction was found from calculation to be 14.8 kcal/mole. (auth)

212 NOVEL SYNTHESIS OF β-DIKETO DIESTERS AND THEIR ANALYTICAL POTENTIAL AS CHELATING AGENTS. Berg, Eugene W.; Adams, Carlton J.; Newkome, George R. (Louisiana State Univ., Baton Rouge). Anal. Chim. Acta; 62: No. 1 49-57(Nov 1972).

A novel procedure was developed for the synthesis of dimethyl-5,7-dioxoundecanedioate,dimethyl-6,8-dioxotridecanedioate and 6,8-dioxotridecanedioic acid from readily available starting materials. The various intermediate and final products of the synthesis were characterized by chemical analyses and by NMR, ir, and mass spectrometry. The chelating ability of the new β-diketones was compared with that of acetylacetone (2,4-pentanedione) on fifteen common metal ions. The β-diketo diesters readily formed precipitates with Be(II), Cu(II), and Pd(II) and red complexes with Fe(III). The green Ni(II) and pink Co(II) complexes were observed only after extracting the aqueous solution with dichloromethane. The β-diketo diacid reacted readily only with Be(II), Cu(II), Pd(II), and UO(II) to form precipitates. Under the same conditions 2,4-pentanedione formed precipitates with all of the ions surveyed. The copper(II) chelates of the two β-diketo diesters were characterized completely. They were stable, soluble in dichloromethane, toluene and xylene, but did not sublime at elevated temperatures and reduced pressures. The copper(II) chelate of 6,8-dioxotridecanedioic acid was characterized and three possible structures are proposed for the complex which exhibits a ligand : metal ratio of 2 : 3. (auth)

213 SYNTHESIS OF SOME SULFATES OF NEPTUNIUM(VI) AND URANIUM(VI). Mefod'eva, M. P.; Krot, N. N.; Bugakova, L. N.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 5, 1423-8(May 1972). (In Russian).

Complex sulfate compounds of Np(VI) and U(VI) were prepared from aqueous solution and were characterized by the following compositions: $K_2NpO_2(SO_4)_2 \cdot 2H_2O$, $Cs_2NpO_2(SO_4)_2$, $Cs_2(NpO_2)_2(SO_4)_3$, $[Co(NH_3)_6]_2 NpO_2(SO_4)_4 \cdot nH_2O$ (n = 5 or 8), $[Co(NH_3)_6]_2 UO_2(SO_4)_4 \cdot nH_2O$ (n = 5 or 8), $[Co(NH_3)_6]_2 (UO_2)_2(SO_4)_5 \cdot 6H_2O$, and $[Co(NH_3)_6]_4 Cs_6[UO_2(SO_4)_4]_3 \cdot 8H_2O$. Properties of these compounds are described. (tr-auth)

Radioactive Waste Treatment

Refer also to abstracts 99 and 139.

214 (DUN-SA-192) TREATMENT OF CHEMICAL WASTES FROM N FUELS PLANT. Tew, H. F. (Douglas United Nuclear, Inc., Richland, Wash.). 6 Sep 1972. Contract AT(45-1)-1857. 8p. (CONF-721030-1). Dep. NTIS.

From Conference on pollution control and abatement at AEC facilities; Oak Ridge, TN, (25 Oct 1972).

Fuel for the Hanford N Reactor is Zircaloy-2 clad tube-in-tube fuel assembly with a metallic uranium core. Treatment and disposal of liquid wastes from fabrication of this fuel are described. Uranium is precipitated and filtered from chemical solutions. Studies were made on evaporation of neutralized waste solutions by solar radiation. Atmospheric evaporation of spent acids neutralized with caustic produced a semi-dry solid having a specific gravity of about 1.5. The wastes were found to evaporate at an average rate of 2.1 in. of depth per month. A conceptual design was developed for an evaporation pond system. (M.C.G.)

215 FLUIDIZED BED CALCINATION OF RADIOACTIVE WASTES USING IN-BED COMBUSTION HEATING. Thompson, T. K.; Lohse, G. E.; Wheeler, B. R. (Allied Chemical Corp., Idaho Falls, Idaho). Nucl. Technol.; 16: No. 3, 396-405(Nov 1972).

The fluidized-bed Waste Calcining Facility (WCF) at the Idaho Chemical Processing Plant has been successfully converted from a liquid-metal heating system to a system called in-bed combustion, where a hydrocarbon fuel is burned directly in the fluidized bed to supply the heat necessary to calcine radioactive wastes. Significant accomplishments demonstrated during the first processing campaign using in-bed combustion heating were an onstream time of 100% over the total run duration of 156 days of radioactive operation, a capacity increase of ~15%, and demonstration of the safety and reliability of the process and control systems. (auth)

216 INSTALLATION FOR CONTINUOUSLY INCINERATING RADIOACTIVE WASTES WITHOUT THE PRODUCTION OF LIQUID EFFLUENTS. Auchapt, Pierre; Bouzou, Georges (to Commissariat a l'Energie Atomique). French Patent 2,100,528. 24 Mar 1972. Filed 18 Feb 1970. (In French).

An installation for continuously incinerating α-emitting waste products arising in the production of Pu is described. The installation consists of a device receiving the waste products, another device for rejecting the metallic casings, which may be mixed with these waste products, a grinding machine, a device for elevating the ground wastes, a storage hopper with a cali-

bration thread, and a sealed incinerator fed with dried air. This incinerator possesses a combustion oven fed with waste falling from the calibration thread and a post-combustion oven heated with electrical elements. These ovens are provided with a recovery hopper for the ashes, a mixer for the gases expelled, an exchanger, and filters. (France)

Radioisotope Production

Refer also to abstracts 88, 94, and 902.

217 (BNWL-CC-1594) ESTIMATES OF PROMETHIUM PURIFICATION COSTS BASED ON OPERATION EXPERIENCE AT PACIFIC NORTHWEST LABORATORY. Voiland, E. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 19 Mar 1968. Contract AT(45-1)-1830. 15p. Dep. NTIS.

This report covers the estimation of costs for isolating and purifying promethium from a concentrate of cerium-free, fission product rare earths and conversion of the resulting product to promethium sesquioxide. The cost estimates are based on PNL operating experience with an R & D hot cell facility which has been used to recover appreciable quantities of promethium over the past three years. Cost projections were made assuming the facility to be staffed and operated solely for the production of promethium, but otherwise operating much the same as in the past; moderate extrapolation of technology is assumed at the highest production rates. The Appendix provides background information on the purification and conversion processes, on the processing facility and associated equipment, and on radiation exposure problems. The Appendix also includes consideration of each step of the existing purification and conversion process to determine the adequacy of existing capability at the four production rates specified, 1, 2, 3, and 6 MCi/yr. Fund and non-fund cost estimates and cost trends as a function of production rates are given. (auth)

218 (RFP-1857) PREPARATION OF HIGH PURITY AMERICIUM OXIDE. Proctor, S. G. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 9 Oct 1972. Contract AT(29-1)-1106. 6p. Dep. NTIS.

Americium oxide was purified using a fluoride precipitation of the rare earth impurities from a solution of hexavalent americium. Additional purification was obtained by successive oxalate precipitations of the americium. The total impurity content of the purified AmO_2 averaged 600 ppM, none of which was contributed by the rare earth elements. (auth)

219 (TID-25955) ^{237}Np: PRODUCTION AND RECOVERY. AEC Critical Review Series. Schulz, W. W.; Benedict, G. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 1972. 94p. Dep. NTIS.

Modified Purex processes are operated at the USAEC Hanford and Savannah River plants to recover kilogram amounts of ^{237}Np from irradiated uranium metal. The Savannah River Purex process is operated to force all the ^{237}Np [as inextractable Np(V)] into the first-extraction-cycle aqueous raffinate, from which it is recovered by sorption on an anion-exchange resin. In the Hanford scheme Np(VI), produced by HNO_2-catalyzed nitrate oxidation of Np(V), is coextracted with uranium and plutonium in the first cycle; neptunium is subsequently separated from uranium in the second uranium cycle. Variables that affect the equilibrium and kinetics of the HNO_2-catalyzed oxidation step are enumerated and described; careful control of these parameters is critical to satisfactory operation of the Hanford recovery scheme. At both the Hanford plant and the Savannah River plant, anion-exchange processes are used to concentrate and purify the recovered ^{237}Np. (Anion-exchange techniques are also used at the Savannah River site to separate and purify ^{237}Np and ^{238}Pu from irradiated $^{237}NpO_2$ targets.) Updated chemical flowsheets for these main-line production-scale ^{237}Np recovery and purification processes are provided and discussed. Several commercial fuel reprocessors in the United States have announced plans for using modified Purex processes to recover ^{237}Np from power-reactor UO_2 and UO_2-PuO_2 fuels, provided such recovery is economically warranted. (The proposed recovery schemes follow closely those now employed at the Hanford and Savannah River plants.) Projections summarized in this review indicate that by 1990 as much as 3500 kg of ^{237}Np could be available each year for recovery from power reactors in the United States. If anticipated demands for ^{238}Pu in medical and space applications materialize, recovery of the major part of this ^{237}Np will be mandatory. Although of less importance than the Purex TBP (tributylphosphate) extraction processes, various other solvent-extraction methods have been developed and applied for recovering ^{237}Np. These include the Redox process (methyl isobutyl ketone extractant) used on a plant scale at Hanford; the combined Redox–TBP extraction scheme used at the U. S. Atomic Energy Commission's Idaho Chemical Processing Plant to recover ^{237}Np from enriched-uranium fuels; and the TLA (trilaurylamine) processes employed in France to purify gram amounts of ^{237}Np recovered from the La Hague Purex plant. Operating conditions and experience for these and other solvent-extraction procedures are presented. Behavior of neptunium in several nonaqueous (fluoride-volatility and pyrochemical) fuel-reprocessing methods is examined. Preparation, properties, and reactions of NpF_6 and its separation from UF_6, PuF_6, and fission-product fluorides are emphasized. No plant-scale application of any of these nonaqueous methods for ^{237}Np recovery has been made. (auth)

220 USE OF HYDROCHLORIC ACID IN SEPARATING ^{95}Zr–^{95}Nb ACTIVITY FROM URANIUM FISSION PRODUCTS ON SILICA GEL. El-Garhy, M.; Shehata, M. K. K.; El-Bayoumy, S. (Atomic Energy Establishment, Inshas, Egypt). J. Radioanal. Chem.; 11: No. 2, 175-8(Aug 1972).

Dissolution of a neutron-irradiated uranium target in a medium of 6N HCl containing a few drops of very dilute HNO_3 yielded a matrix solution, which on running on a silica gel column allowed the complete adsorption of the ^{95}Zr – ^{95}Nb activity formed in the fission process. The ^{95}Zr – ^{95}Nb activity is cleanly and totally eluted with 0.5% oxalic acid solution. None of the uranium or the activity of the other fission products was found to be adsorbed on the column. (auth)

221 EXTRACTION CHROMATOGRAPHY USING CHELATING AGENTS. III. N-BENZOYL-N-PHENYLHYDROXYLAMINE AS A CHELATING AGENT. Sebesta, F.; Laznickova, A. (Technical Univ., Prague). J. Radioanal. Chem.; 11: No. 2, 221-9(Aug 1972).

The extraction-chromatographic behavior of copper, indium, and thorium was investigated on a column with N-benzoyl-N-phenylhydroxylamine in chloroform. Values of the extraction constants of the metal chelates were calculated and found to be in good agreement with the published values. It is possible to calculate the optimum conditions for the separation of the different metals from known extraction constants. The separation of ^{65}Zn – ^{64}Cu; ^{60}Co – ^{59}Fe; ^{60}Co – ^{64}Cu – ^{59}Fe; ^{238}U – ^{234}Th(UX_1), and ^{232}Th – ^{233}Pa in this system is reported. The procedures were used for the preparation of carrier-free ^{234}Th(UX_1) from uranyl nitrate and ^{233}Pa from irradiated thorium. (auth)

222 PRODUCTION OF CARRIER-FREE RADIOISOTOPES FROM TARGETS IRRADIATED WITH DEUTERONS OR ALPHA PARTICLES IN THE U-120 KRAKOW CYCLOTRON. III. PREPARATION OF RADIOISOTOPES OF TERBIUM, DYSPROSIUM, AND LUTETIUM FROM TARGETS OF EUROPIUM, GADOLINIUM, AND THULIUM. Kopta, S.; Petryna, T.; Stronski, I. (Inst. of Nuclear Physics, Krakow). J. Radioanal. Chem.; 11: No. 2, 189-95(Aug 1972).

Results of experiments on the preparation of carrier-free lanthanides from some targets irradiated in the U-120 cyclotron are presented. In the reactions ^{151}Eu(α,n)^{154m,154}Tb, ^{151}Eu(α,2n)^{153}Tb, ^{155}Gd(α,2n)^{157}Dy, ^{169}Tm(α,n)^{172}Lu, and ^{169}Tm(α,2n)^{171}Lu, the isotopes $^{154m,154+153}$Tb, ^{157}Dy, and $^{172+171}$Lu were obtained. These were separated by means of ion-exchange chromatography. (auth)

223 THE ^{122}Te(^{4}He,3n)^{123}Xe $\xrightarrow[2.1\ hr]{\beta^+,\ EC}$ ^{123}I GENERATOR. Lambrecht, Richard M.; Wolf, Alfred P. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 52: No. 1, 32-46(Oct 1972).

The characteristics and applications of a ^{122}Te(^{4}He,3n)^{123}Xe $\xrightarrow{\beta^+,\ EC}$ ^{123}I generator for producing ^{123}I are described. A 46-MeV external ^{4}He beam was used for irradiation. The rate of production of ^{123}I (i.e., based on the continuous collection of ^{123}Xe during the irradiation) was dependent on irradiation conditions, and the crystalline state of the tellurium. Scanning electron microscopy was used to examine the topography of the ^{122}Te as a function of the total alpha dose, of the dose rate, and of post-irradiation annealing. The conditions corresponding to different emanation rates of the ^{123}Xe from the target were evaluated. (auth)

Reactor Fuel Reprocessing

Refer also to abstracts 91 and 92.

224 (GERHTR-35) DETERMINATION OF ^{235}U BURNUP IN THE REPROCESSING OF THORIUM-CONTAINING NUCLEAR FUELS. Brodda, B.-G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Translation of report JUL-715-CT. 14p. Dep. NTIS.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

A relation for the determination of ^{235}U burnup in Th-containing fuels being reprocessed was derived. The relation is based on the knowledge of the U and Th concentrations (g/l) in the process stream and on the dilution factor. A computer program was written for the relation. The time for burnup determination is about 2 hrs, the time necessary for the U and Th determinations. The

computer time is only a few seconds. This paper was abstracted from the original language as 25: 39405. (J.S.R.)

225 EXAMINATION OF A DISSOLUTION PROCESS. Dedaldechamp, Paul; Le Bouhellec, Joel (to Commissariat a l'Energie Atomique). French Patent 2,092,864. 25 Jun 1970. (In French).

This process for examining the dissolution of irradiated nuclear fuels (U–Al and Pu–Al) consists of continuously sampling part of the gas forming during the dissolution of the fuel, and following the changes in the radioactive gas contents (^{85}Kr in particular) using an ionization chamber, the dissolution being continued until the radioactive gas is no longer detected. (France)

ENGINEERING

Energy Conversion

Refer also to abstracts 245–247 and 334.

226 (AD–740121) BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION. Technical Summary Report, December 1, 1970–November 30, 1971. Hansen, Lorin K.; Warner, Charles (Atomics International Canoga Park, Calif.). Mar 1972. Contract N00014-70-C-0196. 142p. (AI–72-7). NTIS.

Results of the past year's work in a program to investigate basic process in thermionic diodes which are important to the realization of practical thermionic energy conversion are presented. The subjects discussed are cesium and cesium-oxygen adsorption on refractory metals, and include a computer program for calculating thermionic converter I-V characteristics. (auth) (GRA)

227 (AD–740551) ELECTRO-BALLISTIC GENERATOR SYSTEM. Final Report. Hasinger, S. H. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Dec 1971. 57p. (ARL–71-322). NTIS.

An EFD-generator system is described which utilizes the electro-ballistic conversion principle in a high-pressure environment. A special process is employed to produce massive charged particles for an effective ballistic process. A stream of droplets produced by a spray nozzle and containing colloidal material is first charged by induction. The droplets are then subject to evaporation with the electric charges transferring to the nonevaporating colloids. In a subsequent supersonic expansion process these charged colloids are used as condensation nuclei to produce charged droplets which are substantially larger than condensation droplets originating from spontaneous condensation, i.e., from an unseeded vapor. Water vapor near critical vapor conditions is used in the present system with particular advantages as operating medium. (auth) (GRA)

228 (AD–740560) INVESTIGATIONS TO DECREASE LOSSES IN MAGNETOHYDRODYNAMIC (MHD) GENERATORS. Final Technical Report, September 15, 1968–July 31, 1971. Eustis, R. H.; Kruger, C. H.; Mitchner, M. (Stanford Univ., Calif. Inst. for Plasma Research). Feb 1972. Contract F33615-69-C-1171. 82p. (SU-IPR–454; AFAPL-TR-72-15). NTIS.

The research program described in the report has included work on boundary layer studies, current distribution and current leakage in MHD generators, and boundary layer diagnostics. A computer program which has been used successfully to calculate conventional turbulent boundary layers has been modified by adding the MHD terms in the momentum and energy equations. Current patterns in conducting wall generators were measured and showed good agreement with theoretical predictions for the anode. The surface-sheath voltage drop was responsible for less good agreement at the cathode. A new method which uses Faraday splitting of laser modes is suggested for the measurement of electron concentration in the boundary layer. A laser doppler velocimeter and its applications to boundary layer velocity measurements in the Stanford generator are described. (auth) (GRA)

229 (GEMS–406(Pt.1)) MULTI-HUNDRED WATT RADIOISOTOPE THERMOELECTRIC GENERATOR PROGRAM. PART I. Annual Report, July 1970–June 1971. (General Electric Co., Philadelphia, Pa. Space Div.). 1971. Contract AT(29-2)-2831. 264p. (GESP–7071(Pt.1)). Dep. NTIS.

Program activities for the period from July 1970 to July 1971 for the development of a ^{238}Pu-fueled Helipak-design heat source for multihundred-watt thermoelectric generators for long-term use in space are reported. Detailed information is included on: heat source design requirements; fuel form development, selection, and criteria; evaluation of Helipak heat source design; compatibility of fuel with candidate encapsulating materials; fabrication reliability; thermodynamic stability analysis, and aerothermal performance evaluation. (L.C.L.)

230 (GEMS–406(Pt.2)) MULTI-HUNDRED WATT RADIOISOTOPE THERMOELECTRIC GENERATOR PROGRAM. PART II. Annual Report, July 1970–June 1971. (General Electric Co., Philadelphia, Pa. Space Div.). 1971. Contract AT(29-2)-2831. 576p. (GESP–7071(Pt.2)). Dep. NTIS.

Program activities for the period from July 1970 to July 1971 for the development of a multi-hundred-watt radioisotope-fueled thermoelectric generator for long-term use in space are reported. These activities included: evaluation of the nuclear safety of the heat source underground handling, shipping, and storage conditions, under pre-launch and launch conditions including accidents involving the launch vehicle, during orbiting flight, and during reentry, impact, and recovery; and development of the thermoelectric converter, i.e., design, fabrication, performance analysis, and testing of converter components. (L.C.L.)

231 (LA–4690) SPACE ELECTRIC POWER R AND D PROGRAM. Quarterly Status Report for the Period Ending April 30, 1971. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 11p. Dep. NTIS.

Declassified 26 Oct 1972.

Resistivity tests on two sheathed insulator assemblies were continued. The resistivity of the samples leveled off at a value of about two orders of magnitude higher than the minimum required for thermionic reactor application. The tests have accumulated over 2000 h of irradiation time and are continuing. Two thermionic converter test units, built and tested by General Electric's (GE) thermionics group and one test unit built by Thermo Electron Corp. to GE specifications and tested by GE personnel, are being disassembled and evaluated. Nine cermet fuel pins were produced for irradiation-testing in the Engineering Test Reactor (ETR). A cross-sectional sample taken from a pin that had been irradiated in the ETR calibration test was examined by various techniques and showed no tendency for interdiffusion between the phase containing uranium and yttrium and the metallic solid solution of molybdenum and tungsten. All molybdenum–tungsten regions were essentially homogeneous solid solutions which were distributed with reasonable uniformity throughout the cermet fuel. (auth)

232 (LA–4747) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JULY 31, 1971. PART II. (Los Alamos Scientific Lab., N. Mex.). Aug 1971. Contract W-7405-eng-36. 15p. Dep. NTIS.

Declassified 26 Oct 1972.

Irradiation capsule K-2 was disassembled after having been irradiated in the EBR-II (Experimental Breeder Reactor) to a maximum fluence of 4.6×10^{21} nvt ($E_n > 0.1$ MeV). The neutron-induced dimensional changes of the Y_2O_3, and Al_2O_3 specimens, and of the Al_2O_3 Nb-ceramic-to-metal seals were determined. The results confirm earlier data, i.e., Y_2O_3 again showed no dimensional increase and AD-999 alumina swelled less than Lucalox. Further diagnostic measurements are in progress. Irradiation capsules K-3 and K-4 were assembled and are scheduled for insertion into the EBR-II blanket in mid-August 1971. These units contain a total of 86 ceramic and trilayer specimens to be irradiated at 450, 600, and 750°C. Thermal-diffusivity measurements on irradiated Y_2O_3 indicated a decrease in thermal conductivity with fast neutron fluence in a manner similar to that of Al_2O_3. At high irradiation levels and 750°C the thermal conductivity of Y_2O_3 is about two-thirds that of high-grade Al_2O_3. A 1.3-in.-dia trilayer specimen was autoclave-bonded without cracking the Al_2O_3 sheath or distorting the circumference of the specimen. A pentalayer test piece was fabricated by a combination of plasma spraying and autoclave-bonding techniques. Metallographic examination of the emitters from General Electric Co.'s in-pile thermionic-converter Test Units SCIP-518, TFE-619, and TFE-621 is under way. Initial results show marked interaction between arc cast tungsten and UO_2. Four cermet-fuel irradiation capsules were assembled for an ETR (Engineering Test Reactor) irradiation series in which the input power densities and irradiation temperatures will range from 100 to 275 W/cm^3 and from 1550 to 1750°C, respectively. Experiments to determine whether liquid lead will prevent excessive loss of hydrogen from $UZrH_x$ moderator rods showed that lead is a very effective barrier. (auth)

233 (LA–4844) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING OCTOBER 31, 1971. (Los Alamos Scientific Lab., N. Mex.). Nov 1971. Contract W-7405-eng-36. 10p. Dep. NTIS.

Declassified 26 Oct 1972.

The neutron-damage model that had been used to correlate radiation-induced swelling of Al_2O_3 was extended to Y_2O_3 and MgO. Values of the neutron-damage parameter were calculated for each material as a function of neutron energy, and a threshold neutron energy was determined which can be used for all three materials to define a damage neutron fluence with a maximum error of 15%. Postirradiation measurements of vacuum integrity were completed for the ceramic specimens and ceramic-to-metal seals included in EBR-II Irradiation Capsule K-2. Leaks were found in two of three Y_2O_3 specimens fabricated from material obtained from the Molybdenum Corporation of America. Two ceramic-to-metal seals were also not vacuum-tight; both had been fabricated by brazing.

Several specimens of autoclave-pressure-bonded trilayers and pentalayers, which are being irradiated in the EBR-II, were characterized with respect to ceramic grain size and metal-ceramic bond strength for comparison with postirradiation values. Determinations of fuel burnup and of the fraction of fission gases released from the fuel were completed for General Electric thermionic-converter Test Unit SCIP-518. The fuel burnup was 2.8×10^{20} fissions/cm^3 of emitter interior volume, and 92% of the fission gases were released from the fuel. Measurements of performance improvement in heat pipes after removal of impurities from the working fluid showed that impurities in sodium stainless-steel heat pipes have a deleterious effect of similar magnitude as in lithium Nb–1%Zr heat pipes. (auth)

234 (LA–4898) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1972. (Los Alamos Scientific Lab., N. Mex.). Feb 1972. Contract W-7405-eng-36. 11p. Dep. NTIS.

Declassified 26 Oct 1972.

A series of ceramic-metal multilayers is being fabricated for inclusion in EBR-II Isothermal Irradiator Capsules K-5 and K-6. The production of various Y_2O_3/Nb–1%Zr pentalayer configurations is being emphasized, but specimens using high-grade Al_2O_3, plasma-sprayed Al_2O_3, and Nb–1%Zr/Al_2O_3 cermet transition layers are also being produced. Confirmation has been obtained that crack-free trilayers can be produced by the hot-gas isostatic pressure technique at 1550°C even when the alumina layer is put into tension and its diameter is increased by more than 1%. This capability expands considerably the design options for ceramic-metal multilayer fabrication. The use of Al_2O_3 transition layers at Y_2O_3/Nb–1%Zr interfaces increased the strength of a Nb–1%Zr/Y_2O_3 trilayer under tension; the effect does not appear to be associated with the ceramic-metal bond strength. Oak Ridge National Laboratory (ORNL) irradiation Capsule EB-2 containing Al_2O_3 specimens has been disassembled. Gross specimen damage was found to correlate best with impurity content, but dimensional increase and posttest specimen strength correlate with grain size. Fission-gas retention and ^{235}U burnup measurements were made for the UO_2-fueled emitters from the General Electric (GE) thermionic converter Test Units SCIP-518, TFE-619, and TFE-621. Retention percentages for ^{85}Kr ranged from 7 to 10% for the first two units listed. Retention measurements for ^{137}Cs also fell within this range. The emitters from TFE-621 operated at considerably higher temperatures, and gas retention was only 2% for the two of the three emitters. The retention value for the third emitter was 24% —a result sufficiently inexplicable to occasion a complete repeat of the measurements. Uranium-dioxide particles ranging in size from 10 to 25 μm have been coated successfully with tungsten layers less than 1 μm thick. This is the first step in an attempt to produce structurally weak W–UO_2 cermets with very high UO_2 content capable of very high fractional release of fission gases. (auth)

235 (UCRL–51217(Rev.1)) NEW CONCEPT FOR IN SITU COAL GASIFICATION. Higgins, G. H. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Sep 1972. Contract W-7405-eng-48. 28p. Dep. NTIS.

A method is described by which deeply buried coals can be converted to methane through chemical reactions with oxygen and water. The coal would first be shattered with conventional explosives, then retorted with an oxygen-water mixture at between 700 and 1300°K. The reactants would be pumped into the top of the coal deposit at between 500 and 1000 psi and carbon dioxide and methane would be removed from the bottom. No sulfur gases or fly ash should be produced and the water requirements can be fulfilled from brackish water supplies. Coals available and suitable for this kind of gasification might yield as much as 10,000 trillion ft^3 of pipeline gas. This constitutes about 300 times the present annual consumption, and if the process is successfully developed, it could materially alleviate future gas shortages. Rough estimates of process costs based on a plant capacity of 0.1 trillion ft^3 per year indicate that an investor could expect about 15% internal rate of return on a $42 million capital outlay assuming 38¢ per MCF of gas as a field price. Both the capital requirement and selling price are much less than for surface gasification plants. Previous underground gasification has been accomplished with mined-gallery or drill-hole low-pressure burning. The method proposed here should minimize bypassing of the coal by the inlet gases and thereby maintain a high-quality product. This is accomplished by flowing the reactant gases very slowly downward through the shattered coal, keeping the hot zones above the colder ones. This creates a thermally stable advancing hot zone and avoids the mixing of reactants and products. The proposed process will lead to ultimate surface subsidence of many tens of feet over the whole area of reacted coal. Experience from potash mines suggests that there would be no surface disruption. While the concept appears most promising from a theoretical point of view, it is unproven. To test its feasibility it will be necessary to conduct a number of laboratory studies and calculations and to perform pilot-scale field tests in suitable deep coal deposits. (auth)

236 SOLAR ERA. PART 3. SOLAR RADIATION: SOME IMPLICATIONS AND ADAPTATIONS. Hay, Harold R. Mech. Eng.; 94: No. 10, 24-9(Oct 1972).

Traditional uses of low-level solar energy in agriculture, the effects of black and white surfaces on radiant energy retention and reflection, examples of how animals, including man, have developed natural coloration which permits the most efficient use of solar radiation, and equipment and methods for using solar energy for natural air conditioning, water cooling and heating, desalination, and ice production are described. (L.C.L.)

237 CHANGE AND EXCHANGE IN INTERNATIONAL ENERGY SUPPLY. Kroeger, Carroll V. Pub. Util. Fortn.; 90: No. 6, 32-41(14 Sep 1972).

Data to 1970 on the population and energy consumption in countries of the world, particularly the US and western Europe, are presented and used to project future energy and fuel requirements. The effects of environmental, sociopolitical, and organizational dynamics are discussed. The following conclusions are reached. A study of the life cycles of any business or industry can be productive in gaining greater insight into the present and future. Change is accelerating in the energy business. Perception of change requires a cinematic view. Energy dynamics no longer are national in character. Past methods may not be sufficient for managing change in the future. A review of past and projected consumption patterns for energy can lead to the conclusion that change will intensify as problems of market development, efficient rationing of resources, and balancing of supply and demand are coordinated on a national and international level. Environmental dynamics of the present and future will require new multidimensioned organizations structured for flexibility and staffed with multidimensioned managers. There is nothing new in the change process. It is our perception of change and the actions we take as a result of that perception related to reality that will determine the effect of change on our individual life cycles. (L.C.L.)

238 NON-COMPENSATED, LIQUID METAL, DIRECT CURRENT MAGNETOHYDRODYNAMIC GENERATOR AND PUMP. Flores, F. (Junta de Energia Nucleare, Madrid). An. Fis.; 67: No. 7-8, 291-300(1971). (In Spanish).

The performance of a non-compensated liquid-metal Faraday-type MHD generator and a similar pump was calculated using a simplified linear model. The main effect is due to the non-compensated current which induces an average non-vanishing magnetic field in the duct-machine. By comparing with compensated machines it is shown that: the non-compensated generator is advantageous over the compensated one if the liquid-velocity, v_0 and the duct-length, L, verify $\mu_0\sigma v_0 L \lesssim 1{,}5$ ($\mu_0\sigma v_0 L \equiv$ magnetic Reynolds number); and the non-compensated pump has a better efficiency over most of its range of performance. (auth)

239 REVIEW OF FISSION ENGINE CONCEPTS. Thom, Karlheinz (Space Nuclear Systems Office, Washington, D. C.). J. Spacecraft Rockets; 9: No. 9, 633-9(Sep 1972).

A review of research on engine concepts based on nuclear fuel in the plasma state for high specific impulse propulsion is presented along with developments and concepts of plasma-core reactor-MHD systems for terrestrial power. Discussions are included on nuclear piston engines and nuclear turbojets. (J.R.D.)

240 CURRENT DRAINAGE TO A HIGH VOLTAGE PROBE IN A DILUTE PLASMA. Grier, Norman T.; McKinzie, Daniel J. Jr. (Lewis Research Center, Cleveland). J. Spacecraft Rockets; 9: No. 9, 706-8(Sep 1972).

Research associated with possible leakage from solar cell-powered generators for satellites as a result of cracks in the cell cover is reported. Data obtained in measurements of electron drainage current through known size holes in three dielectric materials immersed in a 4 km/sec plasma stream are presented. The dielectric materials were a quartz solar cell cover glass, Kapton H polyimide film, and fluorinated ethylene propylene (FEP) type C. The experimental results are compared with results calculated using a computer program. (J.R.D.)

241 THERMODYNAMICS OF MHD CONVERTER CYCLES WITH SEPARATION OF A ONE-COMPONENT LIQUID-METAL WORKING FLUID AHEAD OF THE MHD GENERATOR. Kozlov, V. B. Heat Transfer - Sov. Res.; 4: No. 5, 65-73(1972).

A thermodynamic analysis is made of two possible MHD-converter configurations with separation of the one-component liquid-metal working fluid ahead of the MHD generator with mixing of the streams ahead of the nozzle (configuration I) and behind the MHD generator (configuration II). The thermodynamic

relations between the parameters, the effect of parameter change on the efficiency and the principal sources of irreversible energy losses are examined. The optimal initial vapor contents at the exit from the heat source are determined. A comparison is made of the dependence of the efficiencies of the cycles on the initial vapor content. (auth)

Facilities and Equipment

Refer also to abstracts 334, 632, 2031, and 2215.

242 (CEA-CONF-2045) SOME ASPECTS OF HYDROSTATIC BEARINGS IN SODIUM PUMPS. Elie, X. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). 1972. 4p. (In French). (CONF-720648-16). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

A certain number of problems arise with immersed hydrostatic shaft guide bearings in sodium pumps, mainly at high-temperature operation. Experience has shown that a substantial bearing clearance is required which, in present designs, takes a considerable amount of fluid from the pumps. A new design is suggested, resulting in a very appreciable reduction in the additional flow requirement, while maintaining a comparable load capacity by a hydrodynamic effect. (France)

243 (FRNC-CONF-46) HYDRODYNAMIC INSTABILITY IN AN ELECTROMAGNETIC PUMP. Briot, P. M. H.; Le Frere, J.-P. (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson (France)). 1972. 4p. (In French). (CONF-720648-4). Dep. NTIS (U. S. Sales Only).

From twelfth meeting on hydraulics; Paris, France (6 Jun 1972).

A helical flow was observed in an annular induction pump conduit, which gave rise to a hydraulic instability resulting in a loss of performance at certain operating conditions. A spiral flow due to the Taylor–Goertler effect in an annular space was also studied. (France)

244 (GAT-E-162) FUNCTIONING COMPUTERIZED PM SYSTEM. Rockhold, D. E. (Goodyear Atomic Corp., Piketon, Ohio). 1 Jun 1972. Contract AT(33-2)-1. 17p. (CONF-721021-3). Dep. NTIS.

From Plant engineering and maintenance conference; Baton Rouge, LA. (15 Oct 1972).

A functioning preventive maintenance (PM) system designed and programmed for an in-house IBM-1410 computer is described. The need to update existing PM procedures and records makes it necessary to consider the use of a computer because of storage capacity and speed of operation. The necessary formats of instruction procedures, data input and output requirements, updating techniques, and reports available as printouts are discussed. The total system was designed so that it could be used by the front line supervision involved and manageable through Maintenance and Data Processing departments. The education and understanding guidance of a computer programmer and a maintenance engineer were used to incorporate the necessary requirements to make the system practical and functional. The total scope of the system is not known at this time because it is being used in some situations for scheduling and planning purposes only. It is intended that this paper will contribute and/or generate interest in the field of Plant Engineering and Maintenance to further analyze computer PM systems for helping to schedule and plan required maintenance work. (auth)

245 (NP-19457) REPORT OF THE COMMITTEE OF INQUIRY INTO COLLAPSE OF COOLING TOWERS AT FERRYBRIDGE, MONDAY, 1 NOVEMBER 1965. (Central Electricity Generating Board, [London] (England)). [1966]. 95p. Dep. NTIS (U. S. Sales Only). Central Electricity Generating Board, London. 5 guineas.

The findings of the Committee of Inquiry that investigated the collapse of three cooling towers at the Ferrybridge "C" Power station during a windstorm on Nov. 1, 1965 are reported. Four other towers were damaged during the storm. The Committee found that the tower failures were primarily caused by a serious underestimate of the wind loading in the design, which led to tensile failure of the vertical reinforcement in the lower part of the shells. Constructional defects were not significant. Wind loading deficiencies in both the specification and design were aggravated by a mistaken interpretation of the pressure distribution data. A lack of information on load fluctuations due to wind and on the effect of the towers and station building grouping also handicapped the design. The report contains data derived for the Committee from aerodynamic and structural investigations as research appendices and concludes with strong recommendations for further detailed studies. Interim design methods are recommended to provide guidance while the more fundamental aspects are being investigated, so that new towers may be designed and other vulnerable towers adequately strengthened. (T.D.)

246 (ORNL-TM-3979) WATER POLLUTION AND ELECTRICITY PRODUCTION: THE OPEN CYCLE COOLING TOWER FOR STREAM AERATION: A PRELIMINARY EVALUATION. Burwell, C. C. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 58p. Dep. NTIS.

The advantages of using open-cycle wet cooling towers at thermal power stations to oxygenate, as well as cool condenser cooling water prior to its return to the natural surface water supply are discussed. (T.D.)

247 PLANNING COOLING WATER FOR POWER STATIONS. Gammon, K. M. (Central Electricity Generating Board, Berkeley, Eng.). pp 927-36 of Advances in Water Pollution Research. /Jenkins, S. H. (ed.). New York; Pergamon Press (1969).

From fourth international conference on water pollution research; Prague, Czechoslovakia (21 Apr 1969). See CONF-690463.

Experience of the Central Electricity Generating Board (England) in the use of cooling water at power stations in England and Wales is described. The two cooling systems used include inland tower-cooled stations abstracting fresh water and discharging to rivers and direct cooled stations on tidal waters taking and returning much larger volumes of brackish or salt water. The subjects discussed include: for cooling tower systems, scaling in condenser tubes, effects of purge discharges, operation, and water quality changes; and, for direct cooled power stations, operation, water quality changes, and effects of heated cooling water discharges. It is concluded that: with cooling tower power stations, water is required for evaporation and purges, the chemical changes in cooling water are complex, and the purge discharges can be integrated with benefit into river management schemes; and, for direct cooled power stations, heat is the main addition to the discharged cooling water, rapid successive reheating of the water basin should be avoided, in the grossly polluted tidal Thames heated discharges caused no harm except where anaerobic conditions already existed, and in the unpolluted Blackwater estuary no detrimental effects were found. (L.C.L.)

248 THREE STAGE DIFFUSION PUMP (12 Mar 1970) (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2248).

1 drawing.

This pump is a two-stage diffusion pump followed by a single ejector. The pump is capable of operating at approximately one cm back pressure. The pump is fabricated of glass tubing. (F.S.)

249 SIMPLIFIED APPARATUS FOR SHORT-TERM IRRADIATIONS AT 77°K. Blankenhorn, P. R.; Kline, D. E. (Pennsylvania State Univ., University Park). Nucl. Technol.; 16: No. 3, 462-4 (Nov 1972).

A simplified inexpensive apparatus was devised to irradiate specimens at liquid nitrogen temperatures (~77°K) in a Dewar system. Provisions were also made to maintain the specimen at LN_2 temperatures after irradiation for low-temperature testing. Using the Penn. State University Triga Reactor at a power level of 1 MW, a specimen can receive 10^{14} to 10^{15} nvt integrated fast flux during an irradiation where the Dewar system is filled once. In addition to being inexpensive, the irradiation technique tends to minimize dangers resulting from possible explosions. (auth)

250 STRUCTURE–PROPERTY RELATIONSHIPS IN HEAT PIPE WICKING MATERIALS. Alexander, Ernest George Jr. Raleigh, N. C.; North Carolina State Univ. (1972). 131p. University Microfilms Order No. 72-24,068.

Thesis.

Structure-property relationships in several classes of heat pipe wicking materials have been studied. The properties of porous media that determine performance as heat pipe wicks (permeability, equilibrium capillary height, and effective thermal conductivity) of materials from each class have been determined experimentally. These properties were correlated with structural properties (material of construction, particle shape, particle size, pore size, and porosity). Thus, using the results of this study, it is possible to predict the properties of a porous medium that determine its performance as a heat pipe wick when the structural properties of the wick are known. A simplified analytical model based on appropriate mass, energy, and momentum balances that enables prediction of the critical heat flux of a capillary limited heat pipe is presented and shown to be in excellent agreement with experimental results. (Diss. Abstr. Int., B)

251 DESIGN METHODS FOR STRUCTURES OPERATING AT HIGH TEMPERATURE. Townley, C. H. A. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Des.; 19: No. 1, 99-117 (1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19, No.1).

The past five years has seen the development of analysis techniques to establish stress and strain levels in structures of complex shape operating in the creep range. At the one extreme, there are relatively expensive and time consuming methods using finite elements which require a detailed knowledge of materials behavior, and yield precise information on the stress and strain history in the structure. At the other extreme are approximate methods using the simplest materials data which, nevertheless, often yield information which is sufficiently accurate for engineering application. What is often overlooked is that the calculated results for stresses and strains do not, in themselves, provide a design method. The stress and strain conditions at critical points in the structure must be combined with failure data on the materials of construction, to provide an estimate of the useful working life of the component. A description is given of how a rational basis for design can be developed for structures which are not subject to large cyclic loads, and which satisfy shakedown. The discussion is divided into three parts: the interpretation of the time dependent deformation behavior of the material in a way which eliminates batch to batch scatter and high variables which are important in determining stress levels; the computational and other methods which are available to analyze stresses, strains and distortions in structures of complex shape; and the modes of failure which must be considered in assessing structural integrity. Areas where further research investigations would be worthwhile are outlined. Such investigations would lead to the more economic use of material and, at the same time, give greater confidence in the prediction of structural integrity. (auth)

252 DETERMINATION OF ELASTIC STRESSES NEAR CYLINDER-TO-CYLINDER INTERSECTIONS. Lekkerkerker, J. G. (Delft Univ. of Tech., Netherlands). Nucl. Eng. Des.; 20: No. 1, 57-84(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 1).

An analytical method for determining stresses near cylinder-to-cylinder intersections is described. A survey of relevant literature is given. A discussion of the papers mentioned is aimed at giving the reader an insight into existing possibilities and difficulties. A comprehensive treatment is presented of the stress problem for a cylindrical shell weakened by a circular hole which is one of the parts of a structure composed of a shell and a branch pipe or nozzle. (auth)

253 ANALYSIS OF ELASTICALLY COUPLED SHELLS ON ELASTIC FOUNDATION BY HYBRID METHOD. Zudans, Z. (Franklin Inst. Research Labs., Philadelphia). Nucl. Eng. Des.; 20: No. 1, 85-129(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 1).

The theory governing the hybrid analysis computer program HYBOS is derived and presented in adequate detail for full comprehension of the method and assumptions involved. A brief description of the computer program is given and a nontrivial problem is solved to demonstrate the program capabilities. It is believed that HYBOS represents the most comprehensive tool available as of today, in linear elasticity, to analyze axisymmetric structures for non-symmetric loadings of thermal and mechanical origins. (auth)

254 VIBRATION AND STABILITY OF PRESTRESSED SHELLS. Kalnins, Arturs (Lehigh Univ., Bethlehem, Pa.). Nucl. Eng. Des.; 20: No. 1, 131-47(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 1).

Thin shells are widely used structural elements and are sometimes subjected to time-dependent loads after they have already acquired some prestress. The response of such a shell can be very different from that when the prestress is absent. The general methods of calculation of the response of the shell are discussed. The stability limit of the shell is viewed as a special result obtained in the free vibration analysis. An example of a typical containment shell of a nuclear power plant, housing the reactor, is worked out in detail. (auth)

255 THREE-DIMENSIONAL FINITE-ELEMENT COMPUTER CODE FOR THE ANALYSIS OF COMPLEX STRUCTURES. Zudans, Z.; Reddi, M. M.; Fishman, H. M.; Gray, D. (Franklin Inst. Research Labs., Philadelphia). Nucl. Eng. Des.; 20: No. 1, 149-67(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 1).

General computational procedures are described with emphasis on FORTRAN based "dynamic" storage allocation and adaptability of specialized input routines for the analysis of complex structures, including pump casings and pipe tees and elbows. A brief discussion is given on the algorithms used in this code for the formation and solution of banded linear equations. The basic finite element building blocks, including isoparametric tetrahedra, pentahedra, and hexahedra are described. The results of a complex structural analysis, along with sample computer output, are presented. (auth)

256 FRACTURE OF CYLINDRICAL AND SPHERICAL SHELLS CONTAINING A CRACK. Erdogan, F.; Ratwani, M. (Lehigh Univ., Bethlehem, Pa.). Nucl. Eng. Des.; 20: No. 1, 265-86(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 1).

Fatigue and fracture of cylindrical and spherical shells containing a through crack and subjected to internal pressure or torsion are considered. The stress intensity factor ratios giving the effect of curvature are obtained as functions of a dimensionless shell parameter. By using the conventional plastic strip model the plastic zone size around the crack tip and the crack opening displacement are calculated. The calculated COD values are shown to be in good agreement with the experimental results. The fracture criterion of critical COD is verified by using the results of the burst tests in titanium and aluminum alloy cryogenic pressure vessels. Modified fatigue crack propagation models taking into account the bending effect in shells are introduced and are applied to the analysis of experimental data obtained from flat plates, and cylindrical shells under axial tension, internal pressure, and torsion. Finally, the effect of humidity on the crack growth rate and the effect of load biaxiality on the rupture strength are considered. (auth)

257 THEORETICAL AND EXPERIMENTAL MODES OF BEHAVIOUR OF CYLINDRICAL MODEL PRESTRESSED CONCRETE PRESSURE VESSELS WHEN PRESSURISED TO FAILURE HYDRAULICALLY AND PNEUMATICALLY. Davidson, I. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Des.; 20: No. 2, 575-85(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol. 20, No. 2).

If hydraulic pressure in a prestressed concrete vessel is increased until structural failure occurs, and the deflections are measured, it is found that there are three phases of behavior. The first is a linear elastic phase, which embraces all the normal operating and test loadings: this phase can be thoroughly understood by theoretical analysis for the short term, and probably also for the long term. In the second phase cracks gradually spread through the concrete to produce a very non-linear, but still mainly elastic, response. The third phase involves large deflections with small increases of pressure, and the structure functions as a mechanism. Some knowledge of overload behavior is essential to confirm that a proper margin of safety exists for normal loads, and this has generally involved an examination of the ultimate load factor, which is the termination of phase III. A method of calculating the pressure-deflection curve in phase III is explained, and experimental justification is given. In this work the liner is assumed to remain intact up to the ultimate pressure. If the vessel is pressurized pneumatically, when the liner fails the gas pressure will also act on the walls of the cracks in the concrete. The theoretical consequences of these extra loads are discussed both statically and dynamically. The possible effects of hot gas on the structure are mentioned. From these results it is suggested that the ultimate load factor is too far from reality to provide a really economic solution for the provision of adequate integrity, and it is suggested that a better criterion could be found in the phase II behavior. Some of the basic problems in making a theoretical analysis of the structure in phase II, where major cracks are gradually spreading as the pressure increases are discussed. A relatively novel method of determining the extent of a stable crack is described, and the importance of shear transfer across the cracks is explained. These lead to a suggested application of simplified dynamic relaxation methods which should provide reasonably accurate results at a much reduced cost. Experimental checks on the theory are described. (auth)

258 MEASUREMENT AND PRODUCTION OF SUB-MICRON AEROSOLS. Sinclair, D. (Atomic Energy Commission, New York). pp 132-40 of Proceedings of the 7th International Con-

ference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990.

The concentration of sub-micron aerosols, or condensation nuclei, of approximate diameter from 0.002 to 0.1 microns, was measured with a condensation nuclei counter. The particle size distribution in New York City atmosphere was measured with a series of cluster-tube diffusion batteries of total equivalent length 5.3 km. For ease of construction and portability, a differential diffusion filter, or filter stack, consisting of 9 fibrous filters in series, was devised. It performs like a series of diffusion batteries but requires calibration with an aerosol of known particle size. An induction furnace is being used to generate a sub-micron silver aerosol for calibration of the filter stack. This may be done by means of monodisperse aerosols, if obtainable, if not, by comparison of the performance of the filter stack with that of the diffusion batteries. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 250, 417, 424, 1496, 1497, 1982, 1988, and 2152.

259 (CEA-CONF-2041) EXPERIMENTAL STUDY OF MIXED CONVECTION IN SODIUM. Wendling, M.; Ricque, R.; Martin, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 6p. (In French). (CONF-720648-23). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The results of an experimental study of mixed convection in a vertical channel with a rectangular cross section, which is heated on one side, are given. The qualitative results obtained agree with previous experimental data for conventional fluids (particularly those having low Peclet numbers) in channels with large cross sections. Satisfactory correlation between the volume forces was achieved using the ratio between the modified Grashof number and Reynolds number. A formula is suggested which leads to values for the transfer coefficient similar to those obtained by Russian workers. (France)

260 (CEA-CONF-2043) LOCAL MEASUREMENTS AND THEIR STATISTICAL INTERPRETATION FOR A HIGH VELOCITY TWO-PHASE FLOW WITH HIGH VOID FRACTION. Lecroart, Henri; Lewi, Joseph (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 7p. (In French). (CONF-720648-21). Dep. NTIS (U. S. Sales Only).

From twelfth meeting on hydraulics; Paris, France (6 Jun 1972).

Because of the size of the bubbles in a two-phase high-velocity flow, local measurements require very small temperature probes, which are used in conjunction with a feedback amplifier giving considerably improved time constants. A model for the emulsion is derived from the experimental results, which gives both the diameter distribution and the statistical laws governing the passage of the bubbles past a given point. The gas/liquid interface velocity is found by intercorrelation with a two-electrode probe. (France)

261 (FRNC-CONF-49) PHYSICAL QUANTITIES IN TWO-PHASE FLOWS. Fitremann, M. (Paris Univ., Orsay (France)). 1972. 4p. (In French). (CONF-720648-17). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

In two-phase flows, conservation equations involve variables that are averaged both over a cross section and statistically. Such variables are defined together with other quantities involved in two-phase flow equations, assuming that there is no thermal exchange between the two phases and the walls. (France)

262 SURVEY OF EXPERIMENTAL RESEARCH ON THE MECHANISM OF THE HEAT TRANSFER CRISIS DURING BOILING. Efimov, V. A. Heat Transfer - Sov. Res.; 4: No. 5, 27-38(1972).

A survey is made of the methods and main results of experimental studies of the mechanism of the heat transfer crisis during the boiling of liquids on flat horizontal surfaces in a large pool with natural convection and in ducts during forced motion of the flow. (auth)

263 EFFECT OF A MAGNETIC FIELD ON HEAT TRANSFER DURING FORCED FLOW OF A HEAT-CONDUCTIVE LIQUID. Trusov, V. P.; Alad'yev, I. T. Heat Transfer - Sov Res.; 4: No. 5, 161-72(1972).

An analytical investigation is made of the heat transfer process during laminar fluid flow between parallel plates in the presence of a transverse magnetic field at constant temperature on the walls of the duct. The variational method of Ritz was used to solve the boundary-value problems. The result of the solution was clarification of the effect of a magnetic field on the process of temperature profile formation in the initial section and on stabilized heat transfer. The part played by axial thermal conductivity and internal heat sources in the heat-transfer process of fluids with $Pr \ll 1$ in the presence of a magnetic field was determined. (auth)

Materials Testing

Refer also to abstract 2152.

264 MEASUREMENT OF ANTISCATTER GRID EFFECTIVENESS IN THERMAL NEUTRON RADIOGRAPHY OF HYDROGENOUS MATERIALS. Rau, John A.; Parker, William L. (Reed Coll., Portland, Oreg.). Nucl. Technol.; 16: No. 3, 458-61(Nov 1972).

It is well recognized that scattered neutrons cause serious image degradation in thermal neutron radiography of hydrogeneous objects. If these scattered neutrons are removed from the neutron beam before it strikes the image recording medium, both image contrast and resolution will be enhanced. A method of quantifying the contrast enhancement is illustrated with various antiscatter grid configurations. (auth)

265 STUDY OF SCATTERING RADIATION FROM AN OBJECT IN γ-RAY RADIOGRAPHY. Ho, Nam; Nojiri, Toshiaki. J. Korean Nucl. Soc.; 4: No. 3, 223-8(Sep 1972). (In Korean).

In the radiography of thick materials the scattered rays from an object are one of major causes to reduce the quality of the radiographic image on the film. To determine the rate of scattering of incident gamma radiation by an objective specimen, film blacknesses are measured for various slit widths. For each measurement, the changes of a penetrameter's sensitivity are also evaluated. It is observed that the fault-detectability can be improved by reducing the slit width when the fault detectability deteriorates due to the increase in scattered gamma radiation by thicker samples. This experiment was carried out with iron specimens and ^{60}Co source. (auth)

266 ADVANCED TESTING TECHNIQUES. Symposium Held at Atlantic City, N. J., June 22-27, 1969. Philadelphia; American Society for Testing and Materials (1970). 116p. $5.75. (ASTM-STP-476; CONF-690669).

Information presented at the symposium is summarized in papers on experimental stress analysis, elevated temperature strain measurements, failure prediction by photoelastic methods, fatigue testing of automotive components, low-cycle fatigue testing, environmental effects on fatigue in supersonic transport structures, and fracture toughness testing. (J.R.D.)

267 TESTING OF NUCLEAR COMPONENTS. Straub, H. (Winterthur Engineering Works Div., Switzerland). Sulzer Tech. Rev.; 54: No. 2, 60-72(1972).

Definite requirements are placed on the manufacturers of nuclear components with regard to their organization and manufacturing system. Good manufacturing facilities are also to be accompanied by a suitable infrastructure, which includes planning, design, calculations, computer programming, quality control, production engineering, testing sections, laboratories and, above all, qualified personnel. Because of these requirements, a quality control organization was set up in the Sulzer Group in 1971. This organization is independent of the sections directly concerned with producing the items and guarantees, with its quality assurance program, the customer complete compliance with the stipulated requirements. A description of the most important basic principles used in the testing of nuclear components and in the manufacture of high quality products in general is given in this article. Data, organizational layouts, possibilities and limitations are shown, so that all concerned receive a better overall conception, which improves the co-operation between the individuals involved. (auth)

268 INVESTIGATION OF IRRADIATED FUEL RODS BY NEUTRON RADIOGRAPHY. Mayer, W. A. (AEG-Kernenergieversuchsanlage, Grosswelzheim, Ger.). Kerntechnik; 14: No. 8, 343-6(Aug 1972). (In German and English).

At the AEG Nuclear Test Reactor at Grosswelzheim, a shielded cell was built in which it is possible to carry out neutron radiography of irradiated fuel rods. The method and the facility are briefly described. Most investigations so far were concerned with the inspection of fuel rods from light water reactors, with particular emphasis on the detection of hydrides in the Zircaloy cladding. Neutron radiography is also very valuable for the determination of gadolinium burnup in gadolinium-poisoned fuel rods. (auth)

269 DEFEKTOSKOPIYA METALLOV. (Defectoscopy of Materials). Denel, A. K. Moscow; Metallurgiya (1972). 304p.

Nondestructive methods of testing materials and their control using penetrating radiation are presented. The organization of industrial laboratories for defectoscopy, and examples of the various fields of application are considered. The Russian equivalents of industrial x-ray tubes and gamma-source apparatus (^{60}Co, ^{137}Cs, ^{192}Ir, ^{152}Eu, and ^{170}Tm) are shown in line drawings and photographs. Ultrasound, electromagnetic, capillary, and other techniques are included in the survey. (172 references) (K.S.W.)

Nuclear Explosions

Refer also to abstracts 301, 1947, and 2146–2150.

270 (EERL-MP-E-72-1) EXPLOSIVE EXCAVATION FOR WATER ENVIRONMENT AND ROAD CUT APPLICATIONS. LaFrenz, R. L. (Army Engineer Waterways Experiment Station, Livermore, Calif. (USA). Explosive Excavation Research Lab.). 15 Jun 1972. 38p. (CONF-721108–3). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

The development and uses of chemical explosives for large excavation projects by the U. S. Army Corps of Engineers are reviewed. The technique has been demonstrated on a water conveyance channel in clay shale, a harbor in coral overlain with water, three railroad cuts in a sandstone and shale medium, breaching of a sandbar, and a sidehill road cut excavation. (T.F.D.)

271 (FOA-4-4511-TR-78) SAN FERNANDO EARTHQUAKE, FEBRUARY 9, 1971. Event Report No. 4. (Hagfors Observatory, Stockholm (Sweden)). Sep 1972. 10p. Dep. NTIS (U. S. Sales Only).

Seismic data obtained at the Hagfors Observatory in Sweden from the San Fernando earthquake of Feb. 9, 1971 are presented. (auth)

272 (NVO–116(Vol.1)) ANALYSIS OF LABORATORY OPERATING PRACTICES IN POSTSHOT DRILLING OPERATIONS AT THE NEVADA TEST SITE. (Nevada Operations (AEC), Las Vegas). Jul 1972. 103p. Dep. NTIS.

Postshot drilling activities at the Nevada Test Site (NTS) were examined and evaluated to determine: if there are significant differences in the practices of the Lawrence Livermore Laboratory (LLL) and Los Alamos Scientific Laboratory (LASL) in the conduct of this activity; the nature and meaning of these differences; and qualitative or quantitative or other measurements of these practices. Information is included on: postshot drilling operations at NTS; operational requirements for equipment, labor, and materials; cost analyses; equipment investment; and health and safety requirements. This information is to be used in making decisions on whether to continue or to change present postshot drilling practices in order to achieve great economy or efficiency or both. (L.C.L.)

273 (PNE-WW–11) STRUCTURAL RESPONSE AND ENVIRONMENTAL IMPACT EVALUATION. PHASE 1. PROJECT WAGON WHEEL. (Dames and Moore, [San Francisco, Calif.]). 20 Mar 1972. 387p. Dep. NTIS.

For El Paso Natural Gas Co., Tex.

The Wagon Wheel Event is a proposed Plowshare experiment for evaluating the use of underground nuclear explosions for stimulating natural gas production. The event consists of the sequential detonation of five 100-kton explosives at a site in Sublette County, Wyo. This study was undertaken to determine the effects of predicted ground motions on specific nearby structures, including dams, river bluffs, bridges, water wells and towers, and canals, and to define the environmental impact of these seismic effects. The investigative methods are described in detail. The results which summarize the potential damage to individual structures are tabulated. It is recommended that the detonation take place during Oct. to April when reservoirs in the area are at minimum water level. Generally, slight or no damage is expected to the structures studied under mean ground motion levels. However, damage of significant magnitude is expected if certain structures are subjected to two sigma ground motion levels. (L.C.L.)

274 (PNE-WW–12 and App.A) PRELIMINARY CULTURE SURVEY, PROJECT WAGON WHEEL. Ahlm, J. A.; Power, D. V. (El Paso Natural Gas Co., Tex.). 17 Oct 1969. 95p. Dep. NTIS.

A survey was conducted to locate and document all structures within a 20-mile radius of the site of the proposed Project Wagon Wheel detonation in West Central Wyoming. The structures were classified as: ranches, towns, dams, mines, bridges, towers, irrigation equipment, unusual geologic features, large single buildings such as airport hangars, gas storage plants, etc., and gas wells. The survey method is described and results presented. This information will be used to determine what precautions need to be taken to insure the minimum seismic damage from Project Wagon Wheel. (L.C.L.)

275 REVIEW OF THE GROUND MOTION PREDICTION PROBLEM FOR PLOWSHARE UNDERGROUND ENGINEERING APPLICATIONS. Hays, Walter W. (Environmental Research Corp., Las Vegas, Nev.). Nucl. Technol.; 16: No. 3, 444-57 (Nov 1972).

A ground motion prediction methodology, based on more than ten years experience at Nevada Test Site and incorporating both empirical and theoretical analyses, was developed for Plowshare detonations. Empirical relationships are based on analyses of approximately 4000 seismograms representing a range in yield of 1 to less than 5000 kt, in epicentral distance of from 0.3 to about 350 miles, and in peak surface particle vector acceleration of 10^{-5} to 1 g. On a theoretical basis, mathematical models have been developed which give quantitative predictions of the effects of critical parameters of the source, transmission path, and local recording site geology on the ground motion. This methodology has been validated for two Plowshare gas stimulation detonations, Gasbuggy and Rulison, and is applicable for Rio Blanco and Wagon Wheel. (auth)

276 GROUND MOTION PREDICTION METHOD FOR SIMULTANEOUSLY DETONATED MULTIPLE UNDERGROUND NUCLEAR EXPLOSIVES. Power, Dean V. (El Paso Natural Gas Co., Tex.). Nucl. Technol.; 16: No. 3, 437-44(Nov 1972).

The problem of predicting the seismic signals generated by the simultaneous detonation of a multiple array of underground explosions is considered. A method is proposed whereby the multiple explosion signal or signal parameters may be synthesized from the single explosion signal or signal parameters. This method utilizes the superposition principle of elastic theory and the wave properties of seismic signals to construct a "Coherency Transfer Function" essential to the synthesizing process. Both intuition and experience indicate that signals from multiple explosives can interfere either constructively or destructively. This analytical method is shown to be a good mathematical model by accurately predicting amplitudes for both cases. The method is applied to the results of several single and row charge cratering events and the calculations are compared to measured results. It is shown that when applied to peak amplitudes of velocity, this prediction method gives good agreement with experimental results for both simultaneous detonations and sequential detonations with relatively short time delays. The results indicate that the simultaneous detonation of five close-spaced explosives in the 100-kt yield range detonated in an isotropic medium can result in larger amplitudes of motion than the detonation of a single explosive of equivalent total yield. (auth)

277 REDUCTION OF TRITIUM FROM UNDERGROUND NUCLEAR EXPLOSIVES. Green, J. B. Jr.; Lessler, R. M. (Univ. of California, Livermore). Nucl. Technol.; 16: No. 3, 430-6(Nov 1972).

The industrial application of the Plowshare concept of current interest is the stimulation of natural gas. The degree of success of this and other applications may be significantly affected by the amount of tritium produced by the nuclear explosion. The reduction of residual tritium has been the subject of continuing research and evaluation. Both public safety and economics are considered in planning this reduction. Tritium is produced from two major sources: the explosive itself and the material and rock surrounding the explosive. The improved design of the low-residual-tritium Plowshare underground engineering explosive represents considerable progress in the reduction of the amount of tritium formed. This is shown by the decrease in the total tritium produced in the 29-kt Gasbuggy event from about 40,000 Ci to the estimated <1000 Ci per 30-kt explosive for the Rio Blanco event. Neutron shielding can reduce the amount of tritium formed external to the explosive. Various compositions of borated polyethylene and other neutron-absorbing and moderating materials were investigated. Polyethylene borated at 10 to 25 at.% appears to be best suited for use as an external shield with the Diamond family of explosives, depending upon the specific rock composition. It was found that, in addition to the shielding composition and the lithium content of the rock, the effective temperature of the rock at the time of neutron absorption is very important in determining the tritium production. As an example, the proportion of neutrons undergoing tritium-producing reactions in the Gasbuggy rock changes from ½ to 3½% when the neutrons are absorbed at energies of 1 eV to 1 keV, respectively. A sample case was calculated in which it was found that a 2.5-cm-thick shield of borated polyethylene reduced the total amount of tritium formed in the shield and rock by a

factor of 2 over the unshielded case. A 10-cm-thick shield reduced the total tritium formed by an order of magnitude. (auth)

278 PLOWSHARE STIMULATION OF GEOTHERMAL SYSTEMS. Stewart, D. H. (Battelle-Northwest, Richland, Wash.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 21-2 (1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

279 GASBUGGY SEISMIC SOURCE MEASUREMENTS. Perret, William R. (Sandia Labs., Albuquerque, N. Mex.). Geophysics; 37: No. 2, 301-12(Apr 1972). (SC-R-72-2642).

Gasbuggy, a 29-kt nuclear experiment, was detonated December 10, 1967, at a depth of 4240 ft in the San Juan Basin in New Mexico. Its purpose was to develop techniques for stimulation of natural gas production from tight gas-bearing formations. Data from four subsurface instrument stations in a boring 1500 ft from Gasbuggy indicated formation of a spherical cavity of 88 ft radius and a microfracture radius of about 480 ft. The mean peak value of reduced displacement potentials which defined the seismic source was 2.7×10^6 ft^3. Calculations indicate that about 2% of the energy released remained in the seismic source at 1500 ft. Data from surface motion instruments distributed between surface zero and 8400 ft were similar to those observed above any other contained nuclear explosions. Spalling was indicated at all surface stations. Transient vertical displacements indicate a mound about 6.7 inches high near surface zero and extending through the most remote station where uplift was 0.3 inch. (auth)

280 DETERMINATION OF SOURCE CHARACTERISTICS OF UNDERGROUND NUCLEAR EXPLOSIONS FROM ANALYSIS OF TELESEISMIC BODY WAVES. Bennett, Theron Joseph. St. Louis; St. Louis Univ. (1971). 217p. University Microfilms Order No. 72-23,898.

Thesis.

One of the classical problems of seismology is the recovery of information about the source of seismic waves using observations made at large distances from the focus. In this study long-period seismograph records of the body waves from a relatively simple type of source, an explosion, and applied equalization techniques were used in an attempt to retrieve information about the energy release, the source dimensions, and the strain levels near the focus. A spectral analysis of seventy-five P-wave records and five S-wave records from eight large, underground nuclear explosions was performed. The displacement amplitude spectra in the frequency band from 0.05 to 1.0 Hertz were reduced to the source by application of the method of amplitude equalization. Estimates of the energy spectrum, cumulative energy spectrum, and strain spectrum on the focal sphere were derived for each event from the average displacement amplitude spectrum reduced to the focal sphere. The total P-wave energy in the frequency band from 0.1 Hertz to 0.7 Hertz was computed for each explosion for four different absorption models and the results compared. The energy calculations were found to be strongly dependent on the choice of the absorption model. At the present time, the effect of absorption on body-wave amplitudes is not well understood and is the subject of much discussion. The results presented emphasize the need for an accurate knowledge of the absorption behavior in amplitude studies. The portion of the total P-wave energy to be expected in the limited frequency band from 0.1 to 0.7 Hertz was calculated on the basis of Sharpe's theory and was determined to be of the order of one-sixth for a typical model of a one megaton explosion. Seismic coupling factors were obtained by comparing observed energies to the yields measured independently. These results were again found to be critically dependent on the absorption model. The model which gave efficiencies of the order of 10^{-3} is recommended as being the most appropriate for describing the absorption in the frequency band from 0.1 to 0.7 Hertz; this model corresponds to the assumption that (T/Q_{AV}) equals one and a half seconds where T is the travel time of the ray. Relations between magnitude and band-limited energy and magnitude and yield were developed. The strain level on the elastic-nonelastic boundary of an explosion was computed from the P-wave magnitude using a ray-tracing technique. The value of this strain was found to be approximately 10^{-4}. Based on this same approach, the distance from the focus at which each explosion reached the same level was calculated. The results were compared to observations by others of the radius of the boundary between elastic and nonelastic behavior based on Sharpe's theory and to the relative size of the nonelastic zone obtained by comparing the levels of the strain spectra on the focal sphere. The correlation seems to be fairly good. (Diss. Abstr. Int., B)

281 CALCULATION OF THE RELATIVE CONCENTRATION AND OF THE MASS OF NUCLEAR EXPLOSION FALLOUT PARTICLES. Kownacka, L. (Central Lab., Warsaw). Przegl. Geofiz.; 16: 197-208(1971). (In Polish).

The theoretical prediction of the relative concentration of heavy particles falling on the earth's surface from a cloud which originates from nuclear explosion is discussed. The calculations were based upon a simple linear model of the radioactive cloud, whose size and maximum height in the atmosphere is the function of explosion yield. Particle size-distribution in the cloud is determined by the log-normal function, and their fall-rates were calculated by various methods depending on their respective size. The particle size-distribution on the ground as the function of the distance from the source was calculated assuming the wind velocity to be a linear function of height. Six equations were obtained for determining the relative concentration of the particles on the earth's surface. The GIER computer was used for numerical calculations for small explosions producing clouds in the troposphere and for the distances covered by the local fallout. Curves on the size-distribution and mass of the particles for several distances and explosion yields are presented. Significant differences in shape of the particle size-distribution and mass-distribution for different explosion yields were found. (auth) (INIS)

282 QUANTITATIVE EVALUATION OF SEISMIC SIGNALS AT TELESEISMIC DISTANCES. 3. COMPUTED P AND RAYLEIGH WAVE SEISMOGRAMS. Douglas, A.; Hudson, J. A.; Blamey, C. Geophys. J. Roy. Astron. Soc.; 28: No. 4, 385-410 (Jun 1972).

Body (P) and Rayleigh wave seismograms were computed for explosions and earthquakes using the expressions developed by Hudson; many of the features of observed seismograms were noted. For the earthquake source models used average Rayleigh wave magnitudes relative to P wave magnitudes were larger than for the explosion source models. This was true even for point sources; increasing the dimensions of the earthquake source only accentuated this difference in the relative excitation of Rayleigh waves. However, the relative amplitudes were strongly dependent on the orientation of the observer relative to the fault plane of the earthquake owing to the radiation pattern of the P and Rayleigh waves. Where the observer was at an anti-node of the P radiation the relative amplitudes of the Rayleigh waves were not significantly greater than for explosions. A detailed study of observed P and Rayleigh amplitudes is now needed to see if the same effects of the P radiation pattern can also explain the observed differences in the relative excitation of P and Rayleigh waves by earthquakes and explosions. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 307.

283 , AMOUNT OF MOBILE URANIUM IN EFFUSIVE AND INTRUSIVE ROCKS OF THE EASTERN MARGIN OF THE SOUTH MINUSINSK DEPRESSION. Kovalev, V. P.; Malyasova, Z. V. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Izd. Akad. Nauk SSSR, Ser. Geokhim.; No. 7, 855-66(Jul 1971). (In Russian).

Extrusive rocks are practically devoid of highly mobile uranium, as a result of the leaching of uranium from intrusive and extrusive rocks, embracing a wide range of petrochemical compositions. Glasses, obtained from fusion of intrusive rocks, also firmly retain uranium. The cause of this phenomenon lies in the more uniform distribution of the element in a dispersed and solubilized form in a vitreous, basic mass of extrusive rock, and also in the formation of a screening film of silica gel on particle surfaces which hinders the diffusion of uranium. The disintegration of such films may occur only at sufficiently high temperatures. This action should be considered in the possible mobilization of uranium by hydrothermal solutions from volcanic rocks. (tr-auth)

284 DIAGNOSTICS OF METAMICT URANIC MINERALS. Rakovich, F. I. Inst of Geochemistry and Mineral Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 5, 407-10 (1972). (In Russian).

A comparative study of coffinite, nenadkivite, and uranium silicate, the latter containing up to 1% of titanium, showed that all of them have lower refractive indices in comparison with uranotitanates. This permits, during microscopic investigations, the metamict uranic mineral to be related to the group of silicates or titanates in dependence on the refractive index value. (auth)

285 RAMEAUITE AND AGRINIERITE, TWO NEW HYDRATED COMPLEX URANYL OXIDES FROM MARGNAC, FRANCE. Cesbron, F. (Univ., Paris); Brown, W. L.; Bariand, P.; Geffroy, J. Mineral. Mag.; 38: No. 299, 781-9(Sep 1972).

Two new hydrated uranyl oxides from Margnac, France, are described. Rameauite, $K_2O \cdot CaO \cdot 6UO_3 \cdot 9H_2O$, occurs with uranophane and calcite on pitchblende, agrinierite, $2(K_2O, CaO, SrO) \cdot 6UO_3 \cdot 8H_2O$, with uranophane in small cavities in "gummite". (auth)

286 STUDIES ON THE RADIOACTIVE DISEQUILIBRIUM IN THE SAMPLES FROM KULU AND RAMPUR HIMALAYAS, HIMACHAL PRADESH. Parthasarathy, T. N. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 37: No. 5, 315-23(Sep 1971).

If a sample contains uranium in equilibrium with all the daughter products, then there should be good agreement between the beta assay (U_{beta} or $U_{beta/gamma}$) and the gamma assay (U_{gamma} or U_g or eU_3O_8). This concept was applied to sixty-seven (67) samples of mineralized quartzites from Kulu and Rampur Himalayas and the results analyzed both from radiometric and geological points of view. It is found that while the quartzite samples from Rampur area generally show good equilibrium, those from the Kulu area show some discrepancies due to disequilibrium. The probable causes for this are discussed in the light of the data available so far. (auth)

287 URANIUM MINERALIZATION IN THE PELITIC SCHISTS IN THE KULU HIMALAYA AND ITS PROBABLE ORIGIN. Narayan Das, G. R.; Parthasarathy, T. N.; Taneja, P. C. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 37: No. 4, 267-76(Jul 1971).

Uranium mineralization was observed at Nadahra and Dharagad, in the Tirthan valley (Kulu Himalaya). Uranium shows an affinity for titanium and is observed always in association with rutile both in the muscovite-chlorite schists of Nadahra and the chlorite schists of Dharagad. It is inferred that uranium fixed in argillaceous sediments by adsorption was mobilized and concentrated by metamorphic processes. During the early stages of metamorphism, uranium adsorbed in the clays was released and this facilitated its segregation with titanium. With the continued metamorphism, further mobilization, crystallization and concentration of uraninite with rutile took place along foliation. Uraninite is thus a product of metamorphism. (auth)

288 URANIUM DEPOSITS IN SINGHBHUM AND THEIR DEVELOPMENT FOR USE IN THE NUCLEAR POWER PROGRAMME IN INDIA. Bhola, K. L. (Dept. of Atomic Energy, New Delhi). Proc. Indian Nat. Sci. Acad., Part A; 37: No. 4, 277-96(Jul 1971).

Uranium deposits occur in the metasedimentary and canic rocks of the Iron Ore Series of Archaean Age in the Singhbhum Thrust Belt, and various researchers have studied these from different points of view. New laboratory methods were devised to separate the uranium ore from copper ore mixture. Singhbhum, the richest uraniferous province in India, can play a dominant and key role in the development of nuclear power program and other needs of atomic energy in India. (auth)

Radioactive Effluents

Refer also to abstracts 34, 203, 2099, 2109, 2112, and 2127.

289 RADIATION-HYGIENIC STUDIES AROUND COAL-HEATED POWER PLANTS. Polgar, Erzsebet; Kurczne-Csiky, Ildiko (Orszagos Kozegeszsegugyi Intezet, Budapest). Egeszsegtudomany; 14: No. 2, 188-94(1970). (In Hungarian).

The power plants in Ajka and Inota utilize coal of relatively high radioactivity. Fallout sampling vessels were exposed at two places and, after one-month exposure the ^{226}Ra in the samples was determined. Such samples were examined monthly and the primarily affected wells and streams were also examined. Well-measurable amounts of ^{226}Ra were found in each sample of the sedimented fallout, whereas in the fallout samples collected in Budapest no ^{226}Ra could be detected. The number of samples was too low and the period of time was too short to draw final conclusions. Yet, it may be suggested that utilization of coals of relatively high radioactivity may affect the environment. The object of the present studies was to find out which of the environmental-radiological investigations are most appropriate for the detection of radioactive contamination. Such investigations should be emphasized in the future. The estimation of the possible risk due to the contamination under study needs additional research. (auth)

290 MOBILITY DISTRIBUTION OF ^{222}Rn DAUGHTER SMALL IONS IN LABORATORY AIR. Jonassen, Niels; Hayes, Edward (Technical Univ. of Denmark, Lyngby). J. Geophys. Res.; 77: No. 30, 5876-82(20 Oct 1972).

The unattached positively charged daughter products of ^{222}Rn in laboratory air relatively free of condensation nuclei have been investigated by deposition on aluminum foils in an electric field. The rate of decay of the α activity deposited on the foils at various critical mobilities indicates relative concentrations of ^{218}Po, ^{214}Pb, and ^{214}Bi ions in the ratio 1 : 1.5 : 0.2 independent of the mobility of the ions collected. A normalized activity charcteristic is constructed from the distribution of activity along the strips of foil at various critical mobilities. The mobility distribution, obtained from the second derivative of the characteristic, ranges from 0.3×10^{-4} m^2 v^{-1} sec^{-1} to 3×10^{-4} m^2 v^{-1} sec^{-1}, the mean value being 0.9×10^{-4} m^2 v^{-1} sec^{-1}. (auth)

291 DATA. SECTION III. AIR AND DEPOSITION. Radiat. Data Rep.; 13: No. 9, 513-24(Sep 1972).

Tabulated data are presented from May 1972 measurements of the gross beta radioactivity in the ground-level atmosphere and precipitation at 70 US stations, 24 Canadian stations, and in ground-level air only at 12 Pan American stations, 14 California stations, and at 104 stations in 21 western US states. Jan. to May 1972 measurements of the gross beta radioactivity in the ground-level atmosphere at 6 Mexican stations are tabulated. (L.C.L.)

Radioactivity Monitoring and Transport

Refer also to abstracts 183, 258, 357, and 2226.

292 (NERC-LV-539-1) ENVIRONMENTAL MONITORING REPORT FOR THE NEVADA TEST SITE, JANUARY–DECEMBER 1971. (National Environmental Research Center, Las Vegas, Nev. (USA)). Sep 1972. Contract AT(26-1)-539. 91p. Dep. NTIS.

The off-site radiological safety program for the NTS consists of continuously operated dosimetry and air sampling networks around the NTS. The results of this program, conducted by the National Environmental Research Center–Las Vegas, for 1971 are summarized. (T.D.)

293 (NP-19449) 1971 ANNUAL REPORT OF THE EASTERN ENVIRONMENTAL RADIATION LABORATORY, U. S. ENVI-

RONMENTAL PROTECTION AGENCY. (Eastern Environmental Radiation Lab., Montgomery, Ala.). Aug 1972. 83p.

ACTINIDES—determination in soils by alpha spectrometry
AIR—analysis for krypton-85, method for
ANIMALS—analysis for carbon-14 by liquid scintillation
ATMOSPHERE—krypton-85 content in US
BARIUM-140—content in food and milk in US
BONES—calcium content in US, relation of strontium to
CALCIUM—content in bone and diet samples in US, relation of strontium to
CARBON-14—determination in animals and vegetation by liquid scintillation
CESIUM-137—content in food and milk in US
CHROMOSOMES—radiation effects in Chinese hamster cell, from tritiated luminous compounds
COBALT-58—content in Lake Robinson in vicinity of H. B. Robinson nuclear power plant, Hartsville, S. C.
DIET—calcium content in US, relation of strontium to
ENVIRONMENT—radioactivity monitoring of, calibration and performance of thermoluminescent radiation dosimeters for
FOOD—radioactivity monitoring in US
HAMSTERS—radiation effects on cytogenetics of Chinese, microwave
IODINE-131—content in food and milk in US
KRYPTON-85—content in atmosphere in US
—determination in ambient air, method for
LAKES—radioactivity monitoring in Lake Robinson in vicinity of H. B. Robinson nuclear power plant, Hartsville, S.C.
MICROWAVES—effects on cytogenetics of Chinese hamsters
MILK—radioactivity monitoring in US
NEPTUNIUM-237—determination in fish, radiochemical method for
OSTEICHTHYES—analysis for neptunium-237, radiochemical method for
PLUTONIUM—determination in environmental samples, method for
POTASSIUM—content in food and milk in US
RADIATION DOSIMETERS, THERMOLUMINESCENT—calibration and performance of, for environmental radiation monitoring
RADIUM-226—content in food in US
SOILS—analysis for plutonium, method for
—analysis for actinides by alpha spectrometry
STRONTIUM—content in bone and diet samples in US, relation of calcium to
STRONTIUM-89—content in milk in US
STRONTIUM-90—content in food and milk in US
TRITIUM—effects in luminous compounds on chromosomes in Chinese hamster cells
—monitoring in Lake Robinson in vicinity of H. B. Robinson nuclear power plant, Hartsville, S. C.
VEGETABLES—analysis for carbon-14 by liquid scintillation (R.C.K.)

294 STANDARDIZATION OF UNSOLUBLE COMPOUNDS OF ^{232}Th AND THAT OF NATURAL THORIUM IN THE AIR OF INDUSTRIAL PREMISES. Lyarskii, P. P.; Pavlovskaya, N. A.; Kapitanov, Yu. T. (Inst. of Hygiene and Occupational Disease, Moscow). Gig. Sanit.; No. 4, 64-8(Apr 1972). (In Russian).

A number of parameters are specified that have been used for calculating the average annual permissible concentrations (APC) and the maximal permissible entry (MPE) of ^{232}Th and natural thorium. Results of calculations showed that APC and the maximum permissible concentration of ^{232}Th amounted to 1.0×4.10^{-14} Ci/l and 2.6×10^{-2} μCi/y and that of natural thorium equaled to 0.023 Ci/l and 57.5 μCi/y consecutively, if MMAD particles were 1 μ. For particles with MMAD amounting to 0.06 and 10 μ the values obtained should be divided by 2.86 and 0.4, respectively. (auth)

295 NATURAL RADIOACTIVITY IN OIL FIELDS. Popov, D. K.; Drichko, V. F.; Zel'din, A. L.; Nizhnikov, A. I.; Ponikarov, V. I. (Leningrad Inst. of Radiation Hygiene). Gig. Sanit.; No. 4, 111-13(Apr 1972). (In Russian).

Natural radioisotopes (^{226}Ra, ^{228}Ra, ^{210}Pb, and ^{210}Po) were detected in oil well equipment; however, during normal operation and maintenance of an oil well, radiation doses do not exceed those received by other segments of the population. Water which occurs below the petroleum layer, and the soil contaminated by such water must not be regarded as radioactive waste. A relation is offered which describes the level of α activity at the operation site of the driller's assistant, (P), and the maximum dose level (P_{max}) as measured in the pump-compressor during gamma core sampling: $P = P_{max}/6$ μCi/hr. (K.S.W.)

296 DATA. SECTION IV. OTHER DATA. Radiat. Data Rep.; 13: No. 9, 525-36(Sep 1972).

Results from routine sampling of biological materials and other media not previously reported are presented. Included are environmental radioactivity monitoring activities near the Nevada Test Site during Jan. to July 1969; the Brookhaven National Laboratory during July to Dec. 1969; and the Neutron Devices Dept. during Jan. to July 1971. All radioactivity concentrations were substantially below dangerous levels. A table is presented of June 30, 1972 data on nuclear power reactors in the US. Seismic detection of a USSR underground nuclear explosion during August 1972 is noted. (L.C.L.)

Atmosphere

Refer also to abstract 34.

297 (ORNL-TM-3613) COMPUTER CODE FOR ANALYZING ROUTINE ATMOSPHERIC RELEASES OF SHORT-LIVED RADIOACTIVE NUCLIDES. Reeves, M.; Fowler, P. G.; Cowser, K. E. (Oak Ridge National Lab., Tenn.). Oct 1972. 29p. Dep. NTIS.

A computer code is presented which is used to calculate average annual ground-level air concentrations, deposition rates, and ground concentrations for a decaying chain of radioactive nuclides. Members of this chain are assumed to have been emitted from a stack under routine nonaccidental operating conditions. Averages are performed relative to atmospheric stabilities, wind speeds, and wind directions. (auth)

298 (RFP-1855) DISPER: AN AEROSOL PARTICLE TRANSPORT CODE. Hunt, D. C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 26 Sep 1972. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The code DISPER is used to determine the aerosol particle-source strength outside an enclosure caused by a release of aerosol particles within the enclosure. The release is assumed to pressurize the enclosure and the airborne particles are carried by the escaping gas into leak paths in the enclosure walls. Here, the particles may be deposited on the leak-path walls or remain entrained and escape from the enclosure. The method of problem solution is briefly described and the important equations involved are summarized. The code input and output are given in detail with comments on parameter interpretation which should assist in more general application of the code as, for example, to problems of reactor melt down with associated fuel or fission-product releases. (auth)

299 COAGULATION RATES OF PARTICLES PRODUCED IN AIR BY THORON. Mercer, T. T.; Tillery, M. I. (Univ. of Rochester, N. Y.). J. Colloid Interface Sci.; 37: No. 4, 785-92(Dec 1971). (UR-49-1407).

Thoron produces large concentrations of nuclei in either filtered or unfiltered room air. The coagulation constants (K) of these nuclei and their effective diffusion coefficients, both for number and for activity concentrations, have been determined as functions of time. Values of K ranged from 10.6 to 78.2×10^{-10} cm^3/s, generally supporting the view that the Smoluchowski relationship, with slip factor included, applies to particles having diameters down to about 0.01 μm. For nuclei size distributions having geometric standard deviations between 1.25 and 2.2, the simple assumption that the aerosols were monodisperse, having a diffusion coefficient equal to that determined from diffusion battery measurements, led to calculated values of K in good agreement with the experimental values. (auth)

300 FILTRATION OF 0.001 μm PARTICLES BY WIRE SCREENS. Thomas, Jess W.; Hinchliffe, Lawrence E. (New York Operations Office, N. Y.). J. Aerosol Sci.; 3: No. 5, 387-93(Sep 1972).

The efficiency of four wire screens in filtering a radium-A aerosol was determined. The aerosol consisted of particles of about 0.001 μm diameter. Efficiencies of about 5 to 95% were obtained at air velocities from 5 to 50 cm/sec. Test results were correlated by considering the screens to be assemblies of very short diffusion tubes. The semiempirical screen efficiency equation developed was found to correlate screen efficiency results obtained by other investigators. (auth)

301 ROLE OF RADIOTELLURIUM IN THE MIXTURE OF FISSION PRODUCTS. Slouka, V.; Knajfl, J. (Vojensky Lekarsky Vyzkumny a Doskolovaci Ustav, Hradec Kralove, Czech.). Sb. Ved. Pr. VLVDU Hradci Kralove; 47: 45-60(1970). (In Czech).

The incidence is discussed of tellurium isotopes in a mixture of fission products from a nuclear explosion or from a nuclear reactor accident. The forms of tellurium isotopes in the mixture are briefly described. According to its chemical properties, in the fission products from a nuclear explosion, tellurium will

be present in the form of oxides, mostly on the surface of particles. Results are reviewed which have been obtained by various authors in the investigation of radiotellurium metabolism. (INIS)

302 PERFORMANCE OF VARIOUS IMPREGNATED ACTIVATED CHARCOAL CARTRIDGES AND FILTER PAPER FOR SAMPLING AIRBORNE RADIOIODINE. Naritomi, M.; Fukuda, S. (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 10, 531-9(Oct 1972). (In Japanese).

In order to improve the performance of a commercially available charcoal filter paper and of a charcoal cartridge for collecting airborne radioiodine under high relative humidity, the charcoals were impregnated with triethylenediamine (TEDA), stannous iodide (SnI_2), potassium iodide ($KI + I_2$) or with potassium thiocyanate (KSCN). The impregnated charcoals were examined for their dependence of collection efficiency on the properties of airborne iodine, on the sampling period and on the face velocity, and the results were compared with unimpregnated charcoal as reference. The airborne radioiodine used as samples was obtained from the exhaust ventilation systems at the ^{131}I production plant, and from the fuel reprocessing test plant, both belonging to the Japan Atomic Energy Research Institute. The charcoals impregnated with TEDA or SnI_2 were found to show greatly improved performance compared with the unimpregnated charcoals; the collection efficiency of the charcoal cartridge and of the charcoal filter paper was maintained at levels above 85 and 80%, respectively, over a period of 14 h of sampling. It was found, however, that the collection performance was impaired by the presence of chemically reactive gases such as NO_2 and organic vapor. The charcoals impregnated with ($KI + I_2$) and with KSCN showed almost no improvement in their collection efficiencies. (auth)

303 STOCHASTIC NATURE OF THE ACQUISITION OF ELECTRICAL CHARGE AND RADIOACTIVITY BY AEROSOL PARTICLES. Brock, J. R.; Boisdron, Y. (Univ. of Texas, Austin). pp 141-5 of Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990.

The stochastic nature of mass transfer processes to aerosol particles is discussed briefly, and the calculation procedures for specific cases of unipolar diffusion charging and addition of radioactive or other trace material to aerosol particles are illustrated. It is concluded that even for a monodisperse, stable aerosol, substantial variations in attached charge, radioactivity, trace substances, etc. may arise owing to the stochastic nature of the acquisition processes. In the restricted case discussed, such variations have been shown to be augmented by coagulation of the aerosol particles. In actual physical systems, stochastic spatial, initial, and other distributions may superimpose their variations on those studied here. (L.C.L.)

304 STUDY OF THE EVOLUTION IN ATMOSPHERIC AIR OF NEUTRAL OR IONIZED ULTRAFINE PARTICLES. Huertas, M. L.; Marty, A. M.; Fontan, J.; Blanc, D. pp 150-4 of Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969).

From seventh international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990.

The clustering or agglomeration of neutral and ionized ultrafine aerosol particles and the effects of irradiation of the air on this agglomeration were studied. The results show the existence of a discrete mobility spectrum for small ions of the air, radioactive or not. The maximal value of the ion radius is about 10 Å. The agglomeration is strongly changed by the irradiation of the gas. For ions of the same age the mobility spectrum is very different in a closed volume and in the air of a large room. For a similar irradiation of the air, the neutral particles seem to have a slower agglomeration velocity than the ions. The spectrum of the diffusion coefficient seems to be discrete for $D > 5.10^{-2}$ cm^2 s^{-1}. However, for $D < 5.10^{-2}$ cm^2 s^{-1} a continuous decrease of D as a function of the age of the particles is observed. (L.C.L.)

305 SOME OBSERVATIONS ON THE PROPERTIES OF SMALL ATMOSPHERIC IONS. Bricard, J. (Faculte des Sciences, Paris). pp 129-38 of Supplement Volume of the Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1971).

From 7th international conference on condensation and ice nuclei; Prague, Czechoslovakia(18 Sep 1969). See CONF-690990-(Suppl.).

A brief account is given of the properties of charged particles of molecular dimensions produced by ionization of natural air from the lower atmosphere, i.e., air with normal impurities. The mobility spectra of small gaseous ions and radioactive ions were measured. (L.C.L.)

Soil

306 (BNWL-B-217) STATISTICAL ANALYSIS OF SOIL PLUTONIUM STUDIES, NEVADA TEST SITE. Eberhardt, L. L.; Gilbert, R. O. (Battelle Pacific Northwest Labs., Richland, Wash.). Sep 1972. Contract AT(45-1)-1830. 60p. Dep. NTIS.

The results of efforts to date in the plutonium environmental studies program of the Nevada Applied Ecology Group are summarized. Many of the field studies are currently not completed, but it seems desirable to produce a summary analysis of the statistical aspects at this time. We believe the report will be useful in planning further studies at the test site. It should also serve as a basis for discussion of the kinds of data needed for statistical appraisals of particular problems. Much of the effort thus far has been directed towards the problems of estimating the inventory of plutonium in soil. The only extensive set of data available thus far is from the GMX area. That data suggests that it is quite feasible to proceed with an inventory for GMX with the tools at hand. The other kinds of objectives (described under SAMPLING TECHNIQUES) require more data and various decisions as to what is wanted from the studies. The report provides some preliminary results on the use of the FIDLER instrument in Area 13, but we believe it is not profitable to try to do too much interpretation of such comparisons without more crosschecking FIDLER counts against wet chemistry or similar analyses. Another section of the report provides a basis for decisions on the number of replicates for interlaboratory comparisons. It should be noted that this section serves for planning purposes—once the study is completed, the results should be analyzed by other procedures (most likely an analysis of variance). (auth)

307 (LBL-914) GEOLOGIC-FACTORS CONTROLLING TERRESTRIAL GAMMA-RAY DOSE RATES. Wollenberg, Harold A.; Smith, Alan R. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jul 1972. Contract W-7405-eng-48. 45p. (CONF-720805-5). Dep. NTIS.

From 2nd conference on natural radiation environment; Houston, TX. (7 Aug 1972).

The γ-ray dose rates measured at nearly all terrestrial locations depend mainly on the uranium, thorium, and potassium contents of the rock or soil. Thus, a knowledge of the geologic character of an area aids greatly in the choice of measurement sites and in the interpretation of observed results. Over the past decade the U, Th, and K in many rock types have been measured by γ-ray spectrometry. Igneous rock types measured range from ultramafics to granitics; sedimentary rocks measured include sands and clays, limestones, and eugeosynclinal sandstones; metamorphic types range from low-grade blueschists to eclogite and Precambrian granulites. From the rocks' radioelement contents the gamma-ray dose rates at sampling locations were calculated; these agree well with dose rates measured by a portable NaI(Tl) detector unit, and by other types of instrumentation operated on intercalibration surveys. Data are adequate to characterize rock types and some of their derived soils by radioelement contents and associated radioactivities. Variations in radioelement contents within the batholithic and eugosynclinal sedimentary rocks studied may result from geochemical factors controlled to some extent by features of plate tectonism. Some examples are given. The west-to-east increase in U, Th, and K in granitic plutons of the Sierra Nevada batholith matches an increasing K_2O/SiO_2 ratio, indicating the implacement of magmas of increasing alkalinity, derived from increasing depths of an eastward-dipping subduction zone. Systematic differences in radioactivities of eugeosynclinal graywackes of the Franciscan Formation match zones of low-grade metamorphism, resulting from different pressures on material caught between subducting and continental plates. In the San Francisco Bay area, soils derived from granitic and metamorphic rocks of the continental Salinian block have appreciably greater radioactivities than soils developed on or derived from lower-radioactivity Franciscan rocks. Th/U ratios of the soils are quite similar to ratios in the parent rocks, indicating no appreciable fractionation between Th and U during formation of these soils. (auth)

308 (RFP-Trans-113) CONTRIBUTION TO THE STUDY OF THE MIGRATION OF ^{106}Ru IN SOILS. Amy, Jean-Paul (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Translated for Dow Chemical Co., Rocky Flats Div., from report CEA-R-4168. 4p. Dep. NTIS.

The migration of ^{106}Ru in soils was studied; two solutions of nitrosylruthenium complexes (state in which ^{106}Ru is released

from the Marcoule plant) and a noncomplex ruthenium chloride solution were used in experiments on the mobility of the radioelement, the solutions being percolated through columns containing the soils. The migration depended on the degree of ionization: anionic forms were found to be mobile in the soil, a large fraction being found in the percolate, whereas cationic states were sorbed much more quickly. The nature of the soil also affected the migration process: Ru migrated deeply in sandy soils, whereas it was strongly sorbed by the muddy fractions of soils with a mud sand texture. The mobility of Ru in the soils studied was found to be more dependent on the solution percolation rates than on the particle size distribution; these two factors are, however, closely related. (France)

309 MOVEMENT OF ^{90}Sr AND ^{137}Cs IN CZECHOSLOVAK SOILS. Dlouhy, Zdenek (Nuclear Research Inst., Rez, Czech.); Benes, Jaroslav. Jad. Energ.; 18: No. 8, 273-6(Aug 1972). (In Czech).

As a result of the examination of five of the most abundant soil types in Czechoslovakia, the sorption isotherms of strontium and cesium and the relative speeds of migration of ^{90}Sr and ^{137}Cs through these soils were determined, presenting also variances from the mean values. It was found that the radionuclides in question migrate much more slowly in soil than in water. Retention of radioactive nuclides in the soil reduces considerably the danger of contamination of the water supply in case of an accidental release of radioactivity. (TTT)

310 DATA OF NATURAL RADIOACTIVITY IN JAPAN. Kurokawa, Yoshiyasu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Hoken Butsuri; 6: No. 4, 192-3(Dec 1971). (In Japanese).

Data on uranium (0.48 to 2.89 ppM), radium (0.09 to 1.3 ppM), thorium (2.8 to 20 ppM), and ^{40}K (0.6 to 3.18 ppM) in soils of 40 districts and those of uranium (0.57×10^{-3} ppM on the average), thorium (2.7×10^{-5} ppM on the average), and radium (8.2×10^{-10} ppM on the average) in 10 river waters in Japan are tabulated. Rates of radiation dose from natural radioisotopes in various districts ranged from about 28 to 95 MR/y indoors and from 15 to 134 outdoors. A table of natural radioactivities in underground soils is also given. All data were compiled from literature published in Japan. (Japan)

Water

311 HYDROLOGIC INVESTIGATIONS AND THE SIGNIFICANCE OF $^{234}U/^{238}U$ DISEQUILIBRIUM IN THE GROUND WATERS OF CENTRAL TEXAS. Kronfeld, Joel. Houston, Tex.; Rice Univ. (1972). 78p. University Microfilms Order No. 72-26,442.

Thesis.

Forty-six uranium isotopic analyses were made using alpha spectrometry on waters from the deep Trinity aquifer as well as upon surface waters in central Texas. Most of the surface waters have $^{234}U/^{238}U$ alpha-activity ratios clustering between 1.15 and 1.40. The subsurface waters exhibit extreme isotopic fractionation, being enriched in ^{234}U between several hundred and twelve hundred percent. The uranium content of the subsurface water is less than surface water, the majority falling around 0.02 and 0.04 parts per billion. The most extreme fractionation occurs immediately downdip from the recharge area. From there the activity ratio decreases downdip as a function of the halflife of ^{234}U. There is a corresponding, though non-uniform, decrease in the total uranium content downdip. The Trinity aquifer affords a closed system to an isotope dilution study that utilizes natural $^{234}U/^{238}U$ disequilibrium as a hydrologic tracer. Rates of water flow so derived, 0.7 to 3.0 ft/y, are consistent with the transmissibility values of the aquifer rocks. Laboratory leaching of uranium from the soils and aquifer sand yield $^{234}U/^{238}U$ activity ratios that are very similar to uranium isotopic compositions of surface waters. No extreme fractionation was found in the solid phases. (Diss. Abstr. Int., B)

312 TRITIUM IN THE GROUNDWATER IN JAPAN. 1. Ochiai, Toshiro; Kawasaki, Hironao (Agricultural Engineering Research Station, Hiratsuka, Japan). Yosui To Haisui; 14: No. 3, 255-61(Mar 1972). (In Japanese).

The following methods for measuring tritium are described: measurement by liquid scintillation of water samples; measurement of gas samples by a gas proportional counter; and measurement of gas samples by an ionization chamber. The merits and demerits of the methods are discussed. The first method mentioned was used for hydrological application because of its large capacity to handle several samples. As the concentration of tritium in groundwater is very low, i.e., 0 to 400 TR, it must be condensed to the concentration of about 200 times that of the initial value. The equipment used to condense by electrolysis and the liquid scintillation measuring method are described. Data on tritium concentrations determined at 17 locations in Shizuoka Prefecture and their interpretation are given. (Japan)

313 DATA. SECTION II. WATER. Radiat. Data Rep.; 13: No. 9, 489-512(Sep 1972).

Tabulated data are presented on Jan. 1972 measurements of the gross radioactivity in US surface waters; measurements in North Carolina during 1968 to 1971 of the gross beta radioactivity in raw and treated surface waters and the gross alpha and beta radioactivity cistern water, sewage treatment effluent water, and saline water; and 1969 measurements of gross alpha and beta radioactivity and ^{226}Ra and ^{90}Sr content in community water supplies in 12 states in the US. (L.C.L.)

314 ENVIRONMENTAL MONITORING AND DISPOSAL OF RADIOACTIVE WASTES FROM U. S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES, 1971. Miles, M. E.; Sjoblom G. L.; Burke, R. D. Radiat. Data Rep.; 13: No. 9, 469-78(Sep 1972).

The effect on the environment of disposal of radioactive wastes originating from the U. S. Naval nuclear propulsion plants and their support facilities is assessed. The total radioactivity discharged into all ports and harbors from the more than 100 reactor plants and supporting tenders, bases, and shipyards was less than 0.002 Ci in 1971. This small amount of radioactivity has had no significant or discernable effect on the quality of the human environment. Results of environmental surveys of harbor water and bottom sediment for gross radioactivity and for ^{60}Co show that: no increase in radioactivity has been detected in harbor water; discharges of liquid wastes from U. S. Naval nuclear-powered ships have not caused a measurable increase in the general background radioactivity of the environment; and low-level ^{60}Co radioactivity is still detectable in localized areas of harbor bottom sediment around a few piers at operating-bases and shipyards where maintenance and overhaul of naval nuclear-powered ships have been conducted over a period of several years; these levels have decreased in recent years. This confirms that procedures used by the navy to control discharges of radioactivity from U. S. Naval nuclear-powered ships and their support facilities are effective in protecting the environment and the health and safety of the general public. (auth)

Ecosystems and Food Cycles

Refer also to abstracts 423, 578, 600, and 897.

315 (AECL-4135) ECOLOGY OF THE FIELD IRRADIATOR-GAMMA AREA PRE-IRRADIATION STUDIES. II. BOTANICAL METHODS AND VEGETATION SAMPLING PROCEDURES. Dugle, J. R.; Thibault, D. H. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sep 1972. 32p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The botanical field methods to be followed in the Field Irradiator-Gamma area (FIG) are described, with the major method involving the use of sampling quadrats. Because this is a long-term successional study, all quadrats, plots, and vegetation of special interest must be mapped and permanently marked. The parameters sampled, which include species numbers, diversity, and within species changes will allow a comparison of pre- and post-irradiation levels. The procedures will be amended as required. (auth) (Canada)

316 ^{90}Sr AND ^{137}Cs IN RAW MILKS COLLECTED FROM DAIRIES IN TOHOKU DISTRICT OF JAPAN FROM JUNE 1967 TO AUGUST 1970. Nakanishi, Takeo; Sugawara, Hiroshi (Tohoku Univ., Sendai). Rakuno Kagaku No Kenkyu; 20: No. 3, A107-13 (1971).

Raw milk collected from Miyagi, Yamagata, and Akita prefectures was analyzed for ^{90}Sr and ^{137}Cs. The average values (in pCi/l milk) of ^{90}Sr and ^{137}Cs, respectively, were: Miyagi samples 6.4 and 12.5; Yamagata samples 5.5 and 12.9; and Akita samples 10.5 and 22.7. The average values of ^{90}Sr or ^{137}Cs for 1970 decreased to $\frac{1}{3}$ of the highest values of ^{90}Sr or ^{137}Cs during 1963 to 1964. (EURATOM)

317 ARTIFICIAL RADIOACTIVITY FROM THE FALLOUT AND FOOD IN THE NORTHERN DISTRICTS OF GDR IN THE YEAR 1968. Schulze, H.-A.; Randow, F. (Univ., Rostock, Ger.). Z. Gesam. Hyg. Ihre Grenzgeb.; 16: 68-71(Jan 1970). (In German).

Tests were conducted in the three northern districts of the GDR (Mechlenburg region) in 1968 to determine ambient radioactivity by detecting the nuclides ^{90}Sr and ^{137}Cs in fallout, milk and dairy produce, grain and grain products, vegetables, fruit, and imported fish. The total β-activity was also measured in the fallout. The aggregate values for fallout radioactivity per year

were 25.60 nCi β/m^2, 0.85 nCi $^{90}Sr/m^2$, and 1.55 nCi $^{137}Cs/m^2$, thus exceeding those of the preceding year by 80, 16, and 15%, respectively. The mean values or the ranges of activity for the foodstuffs examined were tabulated. There were no significant changes in the degree of contamination as compared to 1967. The values obtained for tea (1.2 to 3.8 nCi $^{90}Sr/kg$ and 0.8 to 1.5 nCi $^{137}Cs/kg$) were roughly the same as the year before. (auth)

318 DATA. SECTION I. MILK AND FOOD. Radiat. Data Rep.; 13: No. 9, 479-88(Sep 1972).

Data on the ^{137}Cs and ^{90}Sr content of milk sampled at 63 US stations, 5 Pan American stations, and 16 Canadian stations during May 1972 are tabulated and compared with data for the period from June 1971 to June 1972. May 1972 data on the ^{140}Ba, ^{131}I, and ^{90}Sr content of milk sampled at 10 US stations is also included. (L.C.L.)

Radiometric Techniques

Refer also to abstract 34.

319 NEUTRON-ABSORPTION CONTROLLER FOR NEUTRON ACTIVATION LOGGING. Robinson, John C.; Horn, Myron K. (to Cities Service Oil Co.). U. S. Patent 3,691,384. 12 Sep 1972. Filed 2 Sep 1969.

The flux emitted during neutron activation logging is controlled by introducing a neutron-absorbing medium about the neutron-emitting section of a logging tool or sonde. Means are provided to control the rate of neutron-absorbing medium transportation so that a predetermined rate of flux is emitted from the sonde. By controlling the rate of flux emitted from the sonde, an energy gradient is produced such that at a later period of time a gamma ray measuring device may be utilized to log the well which will detect substantially equal levels of radiation at every depth in the well. The tendency of a high degree of gamma radiation existing in the latter portions of the irradiated wellbore is eliminated, thus allowing the use of a singularly scaled detector over the entire wellbore. A more easily measured radiation level results in greater resolution of the reservoir composition, and detection of specific elemental concentration is enhanced. (Official Gazette)

320 RADIOMETRIC INVESTIGATION OF THE WATER REGIME IN ROADBEDS. Gschwendt, I.; Klablena, P. (Vyskumny Ustav Inzinierskych Stavieb, Bratislava). Inzenyrske Stavby; 20: No. 1, 17-21(Jan 1972). (In Slovak).

The results are presented of direct roadbed sampling, and a method is described for long-term radiometric measurement and examination of changes in the density and moisture of roadways. In the given diffusion and pendular water regime, the soil moisture in the upper subsurface layer was found to exceed the optimum moisture of this soil and to be lower than the limit of plasticity for this soil. A description of the radiometric measurement and an evaluation of the results are given. (INIS)

321 U FISSION TRACK METHOD APPLIED TO GEOCHRONOLOGY: DATING OF THE RECENT MAGMATISM IN SOUTH EAST ASIA. Carbonnel, J. P.; Duplaix, S.; Selo, M. (Univ., Paris). Rev. Geogr. Phys. Geol. Dyn.; 14: No. 1, 29-46(Jan 1972). (In French).

The U fission track method was applied to the geochronological study of basaltic zircons. The principle of the method is described. The experimental details applicable to zircons are described. Three age groups were established for zircons in Indochina: 2.4, 1.3, and $0.64 \cdot 10^6$ years. The stratigraphic and tectonic conclusions drawn are presented. (France)

322 TRANSACTIONS OF THE SPWLA THIRTEENTH ANNUAL LOGGING SYMPOSIUM. Conference Held at Tulsa, Oklahoma, May 7–10, 1972. Houston, Tex.; Society of Professional Well Log Analysts (1972). 312p. $12.00. (CONF-720548).

Twenty-eight papers were presented at the conference; a separate abstract was prepared for each of 6. Twenty-two papers were not in scope for NSA. (L.C.L.)

For abstracts of individual papers see: 323–328.

323 NOTES ON THE ACCURACY OF THE NEUTRON LIFETIME MEASUREMENT. Wichmann, P. A. (Dresser Industries, Inc., Houston, Tex.). pp A,1-15 of Transations of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

During the past several years a number of papers have been published which point out that the most well-known commercial logging devices for the measurement of the thermal neutron capture cross section do not always agree in the absolute values measured. There are a number of reasons for these discrepancies, including different philosophies in tool design, gating systems, and types of detectors. The results are reviewed of a series of tests in a variety of controlled environments and also actual logged results for one of these devices, the Dresser Atlas Neutron Lifetime Log. The controlled environments include the API test pits and several test tanks in which measurements were made with boric acid in concentrations such that the capture cross section of the solutions varied up to a maximum of almost 100 sigma units ($0.1\ cm^{-1}$). The field results include multiple runs in the same borehole under a wide spectrum of different possible borehole conditions, including holes that are air or gas and fluid filled, cased and uncased, and high to low salinity fluid filled. The results of instruments of varying diameter are also compared. The inescapable conclusion of these test measurements and field results is the fact that the Neutron Lifetime Log measures the value of thermal neutron capture cross section with an exceptional accuracy. (auth)

324 SOME FEATURES OF DUAL-SPACED NEUTRON POROSITY LOGGING. Allen, L. S.; Mills, W. R.; Desai, K. P.; Caldwell, R. L. (Mobil Research and Development Corp., Dallas). pp G,1-11 of Transactions of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

The principal features of dual-spaced thermal neutron logs for porosity are reviewed. While field results have generally confirmed the predicted insensitivity to changes in borehole size, tool standoff, and the type of fluid in either the borehole or the formation, they have also demonstrated that these logs respond somewhat anomalously in dolomite formations. By anomalous it is meant that the departure from limestone normalization is approximately two to three times as large for dual-spaced logs as for single-detector sidewall porosity logs. It is proposed that this anomaly can be caused by very small amounts of strong thermal neutron absorbers in the formation, and is particularly pronounced if the source-detector spacings are too short. This possibility was investigated using two-group neutron diffusion theory in conjunction with published neutron slowing down, thermal diffusion, and thermal absorption parameters. Expected concentrations of boron and gadolinium are used to illustrate the effect. Three different types of fast neutron sources were studied in connection with the dolomite anomaly. They are assumed to emit monoenergetic fast neutrons with energies of 2.4, 4.0, and 14 MeV. These energies correspond closely to the average energies of neutrons produced by ^{252}Cf spontaneous fission sources, alpha-beryllium radionuclide sources, and deuterium–tritium accelerator sources, respectively. All of these sources can be employed currently in this application. A field example of the dolomite anomaly is discussed. (auth)

325 NEW THEORY OF THE WELL LOGGING CHARACTERISTICS OF HYDROCARBON-BEARING SANDSTONES. Barlai, Zoltan (Hungarian Oil and Gas Trust, Budapest). pp J,1-61 of Transactions of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

According to theoretical and laboratory investigations, the well logging characteristics of hydrocarbon-bearing sandstones are strongly affected by the mineralogical composition of rock-forming solid grains, by grain sizes and ion types, and concentrations in interstitial waters and mud filtrates. Among the mineralogical constituents of solid grains, except for clay minerals, the influence of sheet silicate (micas, chlorites, etc) on the well logging parameters is especially great and important. The influence increases with decreasing grain sizes. The effect of fine sand grains is appreciable, and that of silt grains is very strong, especially concerning the electric and gamma-ray characteristics of sandstones. The ion content of interstitial waters and mud filtrates influences first the electric and neutron properties. The effect of the matrix on electric properties increases with a decreasing ion content of pore fluids. The effect of pore fluids on neutron properties becomes stronger with increasing ion concentrations. These effects were studied using theoretical and laboratory investigations and well log analysis. New mathematical formulas were derived for the well logging characteristics of sandstones. For this derivation microphysical rock properties were applied as a first step, then bulk rock (macrophysical) parameters introduced for practical interpretation purposes. These new formulas and studies of laboratory measurements are presented. The theoretical possibility of quantitative well log analysis on the basis of the new formulas is considered. (auth)

326 DUAL SPACING NEUTRON LOG (CNL) IN VENEZUELA. Hung, J. Enrique (Corporacion Venezolana del Petroleo, Maracaibo); Salisch, Henry A. pp T1.-22 of Transactions of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

The Dual Spacing Neutron Log, known also as the Compensated Neutron Log, or simply CNL, has been run commercially in Eastern Venezuela and on Lake Maracaibo. Prior to the introduction of the CNL, the Sidewall Neutron Porosity Log (SNP) was extensively used throughout Venezuela for formation evaluation purposes in shaly sands and to differentiate gas from oil reservoirs. In both cases the SNP was generally run with the Formation Density Log as a companion log. The new CNL can now be recorded in combination with the density log, thus making it possible to obtain, in a single run into the borehole, depth-matched porosity measurements which can be used to detect and evaluate clean and shaly oil- and gas-bearing reservoirs. The presence of mud cake and rough borehole walls affect the CNL to a much smaller degree than the SNP; its ability to investigate deeper into the formation makes it more sensitive for gas detection. Whereas the SNP tool was designed for use only in open hole, the CNL can be run in open or cased hole and gives in both cases comparable porosity readings. The Compensated Neutron Log has been eminently successful since its introduction into Venezuela. Qualitative as well as quantitative results will be presented of experience gained during the first year of use of the tool there. The examples presented will show several of the more important features of the tool. (auth)

327 PROGRESS REPORT ON INTERPRETATION OF THE DUAL-SPACING NEUTRON LOG (CNL) IN THE U.S. Truman, R. B. (Schlumberger-Doll Research Center, Ridgefield, Conn.); Alger, R. P.; Connell, J. G.; Smith, R. L. pp U.1-34 of Transactions of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

A unique two-detector neutron tool was developed and introduced commercially in the United States. More than 600 open-hole logs and 150 cased-hole logs have since been recorded. This new tool records a Compensated Neutron Log (CNL) for which the effects of hole conditions (mud cake and rough borehole walls) have been minimized and are generally small. Since the CNL may be run in combination with other logging tools, rig time is saved and well-site interpretation becomes easier. Recorded with the density log, the CNL delineates gas-bearing intervals in sand-shale sequences. A simple crossplot method delineates shaley gas zones on which gas effect is less apparent. The new neutron log investigates more deeply into the formation than the density. This complicates the computation of porosity in gas-bearing zones, but makes gas zones easier to find. For instance, in most low-porosity gas zones, the porosity is given directly by the density whereas the CNL shows an appreciable gas effect. The CNL has a greater shale effect than the epithermal neutron tools such as the SNP. Studies, made in numerous wells where both types of neutron logs were recorded, show that the CNL can be used in determination of both bulk-volume fraction of shale and porosity. A study of CNL responses in different lithologies was made. The results show greater matrix effect on the CNL than on other neutron tools. Porosity derived from the CNL-density is potentially more accurate than that derived from previous neutron-density by computations. Comparisons of open- and cased-hole CNL logs confirm laboratory-derived departure curves. In suitable cases, the cased-hole CNL can be combined with open-hole data for determination of gas, lithology, and improved porosity. (auth)

328 LOG ANALYSIS METHOD FOR EKOFISK FIELD, NORWAY. Owen, Joe D. pp X.1-22 of Transactions of the SPWLA Thirteenth Annual Logging Symposium. Houston, Tex.; Society of Professional Well Log Analysts (1972).

From 13th annual logging symposium; Tulsa, OK. (7 May 1972). See CONF-720548.

The producing section in the Ekofisk Field is a thick, highly porous limestone. Conventional log analysis gives erroneous values for porosity when compared to core analysis. Detailed investigation of the responses of the various porosity tools have shown that this results largely from hydrocarbon effects on the tool response. A method employing the SNP and FDC logs has been utilized to make the necessary corrections so that log derived porosities agree with core analysis. The method can be employed in the field by use of simple graphical methods but has been programmed for use on a large computer. (auth)

329 USE OF ISOTOPIC METHODS FOR THE DETERMINATION OF THE PRESENT RATE OF SNOW ACCUMULATION ON THE ANTARCTIC CONTINENT. Vilenskii, V. D.; Teis, R. V.; Emel'yanov, V. V.; Kochetkova, S. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 9, 1071-82(Sep 1972). (In Russian).

Results of isotopic measurements of snow accumulation rates in regions of the Molodezhnaya, Mirny, and Vostok stations are considered. During determination of the snow accumulation rate and the singling out of annual layers in recent glacial deposits of coastal and midland regions of the Antarctic continent it is advisable to use, along with stable isotope variations, also seasonal radioactivity variations. The exactness of the snow accumulation rate determination according to the change of ^{210}Pb concentration with depth (when ^{210}Pb is determined in snow samples, corresponding to an accumulation period of ~10 years) cannot be increased at the expense of using thinner samples owing to the variations of ^{210}Pb concentration. In order to estimate the unevenness of the contemporaneous snow accumulation at some points of the same region, methods are suggested for measuring the snow cover deposited since 1955 in three zones which differ in radioactivity levels. (auth)

330 PROCEEDINGS OF THE 7th INTERNATIONAL CONFERENCE ON CONDENSATION AND ICE NUCLEI, SEPTEMBER 18–24, 1969, PRAGUE AND VIENNA. Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1969). 465p. (CONF-690990).

Eighty papers were presented at the conference. A separate abstract was prepared for each of five. Seventy-five papers were not in scope for NSA. (L.C.L.)

For abstracts of individual papers see: 180, 181, 258, 303, and 304.

331 SUPPLEMENT VOLUME OF THE PROCEEDINGS OF THE 7th INTERNATIONAL CONFERENCE ON CONDENSATION AND ICE NUCLEI, SEPTEMBER 18–24, 1969, PRAGUE AND VIENNA. Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1971). 370p. (CONF-690990-(Suppl.)).

Thirty-one papers were presented at the conference and are included in this supplement. A separate abstract was prepared for each of three. Twenty-eight papers are not in scope for NSA. (L.C.L.)

For abstracts of individual papers see: 46, 305, and 332.

332 SPREADING AND RAINOUT OF PASSIVE ADMIXTURE INJECTED INTO CLOUD. Shopauskas, K.; Styra, B.; Vebra, E. (Inst. of Physics and Mathematics, Vilnyus, USSR). pp 340-6 of Supplement Volume of the Proceedings of the 7th International Conference on Condensation and Ice Nuclei. /Podzimek, Josef (ed.). Prague; Academia, Publishing House of the Czechoslovak Academy of Sciences (1971).

From 7th international conference on condensation and ice nuclei; Prague, Czechoslovakia (18 Sep 1969). See CONF-690990-(Suppl.).

A series of experiments using ^{32}P and ^{210}Po as tracers were performed to investigate the dispersion of radioactive aerosols within an atmospheric cloud and to measure the rainout of these aerosols. The tracers were injected by explosive rockets. The results showed: isotope spreading took place in all directions irrespective of the main airstream direction; spreading is dependent on where the isotopes were injected relative to the cloud center; fallout density was greater for ^{210}Po than for ^{32}P; and fallout density distribution on the ground varied and seemed related to turbulent processes in the cloud. (L.C.L.)

Site Surveys

333 (DOCKET-701257-3) MIXED OXIDE FUEL PLANT. Applicant's Environmental Report, Revision 1. (Jersey Nuclear Co., Richland, Wash.). Oct 1972. 20p. Dep. NTIS.

This revision of Docket-701257-2 consists of replacement and supplemental pages. This revision was necessary because of an algebraic error in the calculation of MPC and a tabular error for $\overline{\omega}$ in Table 5.2 of the original document. However, the changes do not alter the original conclusions. (T.D.)

Thermal Effluents

Refer also to abstracts 246, 600, 2070, 2099, 2109, 2112, and 2127.

334 ADVANCES IN WATER POLLUTION RESEARCH. Proceedings of the Fourth International Conference Held in Prague, April 21–25, 1969. Jenkins, S. H. (ed.). New York; Pergamon Press (1969). 946p. $18.00. (CONF-690463).

Fifty-five papers from research studies related to stream pollution, waste water management, lakes, reservoirs, and the marine environment were presented at the conference. A separate abstract was prepared for one paper. 54 papers are not within the scope of NSA. (L.C.L.)

For an abstract of an individual paper see: 247.

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 293 and 2216.

General Detectors and Monitors

Refer also to abstracts 1088, 1580, 1952, and 1972.

335 (LBL–1035) IMPROVED DELAY LINES FOR PROPORTIONAL WIRE CHAMBER READOUT. Grove, R.; Perez-Mendez, V.; Sperinde, J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 11p. Dep. NTIS.

Various modifications to the electromagnetic delay lines used for wire chamber readout are described. These modifications consist of changing the cross-sectional area of the lines and decreasing the eddy current losses and the dielectric losses. Also, the characteristic impedance of the lines is increased. The effect of these modifications is to increase the coupling efficiency to the chamber wires and to make the delay-to-risetime ratio equal to 30 for a 50 cm. long delay line. (auth)

336 (NP–19462) SOLID STATE CHARGED PARTICLE SPECTROMETER IN THE ROCKET PROTON I. Report No. 40. Lindalen, H. R.; Soeraas, F.; Njaastad, S.; Ryngoeye, T. (Bergen Univ. (Norway). Dept. of Physics). Apr 1972. 23p. Dep. NTIS (U. S. Sales Only).

The experiment was designed for use in rockets with a pulse code modulated (PCM) telemetry system. It will measure the differential energy spectrum and pitchangle distribution of electrons and protons above 20 keV with high resolution. It is part of the payload in the two Nike-Tomahawk rockets, Proton I and II, which have been built to investigate various aspects of the particle precipitation at high latitudes with emphasis on the proton precipitation. Proton I was launched on February 13, 1972, and, while it is too early to present scientific results, it is apparent that the equipment has functioned as expected. (Norway)

337 (SC-DR–720118) COMPTON DIODES: THEORY AND DEVELOPMENT FOR RADIATION DETECTORS. Fewell, T. R. (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 44p. Dep. NTIS.

The Compton diode is examined from an engineering aspect. A brief operational-type discussion of the detector is presented; each component of the Compton diode is examined in both theory and experiment. Special emphasis is placed on designing a Compton diode which is very reliable but simple in construction. It is shown that one can design a detector whose signal is nearly equal to the number of electrons impinging upon the collector. At radiation levels and rates used in experiments, the detector is essentially insensitive to problems such as charge buildup in dielectric, electron backscattering, and other factors. Some design hints are also given to solve problems which could occur at higher radiation levels. (auth)

338 VARIABLE BASELINE SCANNER. Oberley, L. W.; Ehrhardt, J. C.; Lensink, S. C. (Univ. of Iowa, Iowa City). Phys. Med. Biol.; 17: No. 5, 630-7(Sep 1972).

The spectral changes associated with source-detector geometry have led to the development of a variable baseline scanner. In clinical situations it produced images superior to those obtained with a constant baseline. (auth)

339 CHARACTERISTICS OF SPIRAL CHANNEL MULTIPLIERS. Krasil'nikova, N. A.; Persiantseva, N. M.; Talashov, L. G. (Scientific-Research Inst. of Nuclear Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 194-5 (1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 168-9(1972).

The operation of spiral channel multipliers as detectors of electrons having energies of 5 to 10 keV was investigated. The current and counting characteristics were obtained, and the counting efficiency of the multipliers was measured. (auth)

340 COMMENT ON $\gamma-\gamma$ DIRECTIONAL CORRELATION MEASUREMENTS IN EVEN–EVEN NUCLEI. Taylor, H. W. (Univ. of Toronto). Nucl. Instrum. Methods; 104: No. 2, 401-2 (1972).

A method for using 4(2)2(2)0 and 0(2)2(2)0 spin sequences to produce reference correlations for directional correlation measurements in even–even nuclei is outlined. (auth)

341 STUDIES ON THE MEASUREMENT OF THE DISINTEGRATION RATE OF ^{63}Ni BY 4pi-beta COUNTING. Lachance, Y.; Roy, J. C. (Univ. Laval, Quebec). Nucl. Instrum. Methods; 104: No. 2, 393-400(1972).

Some problems arising in the measurement of the absolute disintegration rate of ^{63}Ni sources evaporated on thin plastic films are discussed. A novel technique for obtaining low and reproducible self-absorption values is described; it is based on the evaporation of the radioactive solution on 2 to 3 $\mu g/cm^2$ of silicon monoxide (SiO) vacuum evaporated on the plastic film. The technique has been applied to the preparation of ^{60}Co, ^{203}Hg and ^{63}Ni sources. It has been found that the absorption of ^{63}Ni in the source mount depends on the self-absorption and that the correction factor increases from 0.06% to 0.12% per $\mu g/cm^2$ when the self-absorption increases from 10% to 60%. The meaning of the counting region for ^{63}Ni and other radionuclides is also discussed along with other problems. (auth)

342 SURFACE BARRIER PARTICLE DETECTORS. Hansen, N. J.; Scott, R. G.; Henderson, D. J. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 104: No. 2, 333-6(1972).

Techniques are outlined for the fabrication of surface barrier charged particle detectors. It has been found that the best results are obtained when the gold evaporation is carried out in wet oxygen at pressures of the order to 5×10^{-3} torr. Detectors fabricated using these techniques have been shown to survive long exposure to a high vacuum environment. (auth)

343 ELECTROVACUUM INSTRUMENTS FOR INVESTIGATING HIGH-SPEED PROCESSES. Akimov, Yu. A.; Fromberg, A. B. Meas. Tech. (USSR) (Engl. Transl.); 15: No. 3, 345-9(Mar 1972).

Translated from Izmer. Tekh.; 15: No. 3, 3-5(Mar 1972).

Electrovacuum instruments, which record and measure pulsed radiation with a duration of a few nsec, are briefly described. The most suitable and accurate method of recording and studying these pulses is by linearly converting the radiation into a proportional electric signal and recording the signal on high speed electron beam tubes. (F.S.)

344 RAPID METHOD OF ESTIMATING BETA-RADIATION DOSE. Vukolov, V. I.; Shevyrev, V. S.; Shtemberg, S. V. Meas. Tech. (USSR) (Engl. Transl.); 15: No. 3, 437-40(Mar 1972).

Translated from Izmer. Tekh.; 15: No. 3, 56-8(Mar 1972).

Doses of β radiation are estimated by an ionization chamber using measurements of the ionization current strength with and without an absorber. (F.S.)

345 AUXILIARY REVERSIBLE COUNTER FOR THE DETERMINATION OF COUNTING RATE DIFFERENCES. Koenig, K. H.; Goerner, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 15: No. 3, 94-7(Mar 1972). (In German).

In determining counting rate differences, the reversible counter can favorably be replaced by a small reversible counting capacitor buffering a normal counter if the "positive" counting rate is sure to exceed the "negative" one significantly. Two versions of the auxiliary counter are compared, and the corresponding systematic counting errors are discussed. It is concluded which circuitry is to be preferred. (auth)

346 LOGIC SYSTEM FOR TREATING INFORMATION PROVIDED BY NUCLEAR DETECTORS. Pages, Roland (to Societe d'Applications Industrielles de la Physique). French Patent 2,094,480. 10 Jan 1972. Filed 23 Jun 1970. (In French).

Logic units used in conjunction with multiwire proportional chambers are described. The particular logic unit developed enables all the information to be memorized (whether or not it represents an interesting event) with a reduction in the resolution time and the time taken to explore the memory. The invention incorporates the following advantages: a certain number of filaments can be connected in or out of circuit; the unit can be instantaneously controlled; a memory with a controllable storage time is incorporated; and a special system is used for alerting the central decision part and the fast memory reader. (France)

347 IEEE STANDARD TEST PROCEDURES FOR PHOTOMULTIPLIERS FOR SCINTILLATION COUNTING AND GLOSSARY FOR SCINTILLATION COUNTING FIELD. ANSI N42.9-1972 (IEEE Std 398-1972). New York; Institute of Electrical and Electronics Engineers, Inc. (1972). 28p.

A standard prescribing requirements for test procedures for photomultipliers for scintillation and Cherenkov counters is presented. (W.H.K.)

348 PARTICLE TRACK ETCHING. Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.); Alter, H. W.; Furman, S. C.; Price, P. B.; Walker, R. M. Science; 178: No. 4058, 255-63(20 Oct 1972).

A survey is presented of the diverse technological applications of etched particle tracks. Applications are divided into four categories: porous membranes (filters and particulate counters), imaging and mapping, radiation dosimetry, and miscellaneous. Methods for enhancing the etched particle tracks are considered. 71 references. (D.L.C.)

349 CRYSTALLINE FILAMENTARY PARTICLE COUNTER. Pisarev, A. F.; Pisarev, V. F.; Revenko, G. S. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 58-60(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 86-8(20 Jul 1972).

The counter has a brass cylindrical cathode of 6 mm diameter and a tungsten filament of 10 μ diameter coated with a thin film of gold. The amplitude and counting characteristics of frozen argon and frozen xenon are graphed and discussed. From the amplitude characteristics the counter has three typical sections: ionization up to 2 kV, proportional up to 5.2 kV, and saturation above 5.2 kV. (W.H.K.)

Radiation Dosimeters

Refer also to abstracts 603 and 1846.

350 (CLOR-89/D) THERMOLUMINESCENT FINGER GAMMA RADIATION DOSIMETER. Koczynski, A.; Wolska-Witer, M.; Musialowicz, T. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1972. 31p. (In Polish). Dep. NTIS (U. S. Sales Only).

Thermoluminescent finger dosimeters (TLDP) based on commercially available Polish-made TL material for measurements of gamma radiation doses to hands over 100 mR, have been developed. The dosimeters have been prepared in two types: TLDP-1 with 10 mg powder of CaF_2:Mn in Al silver-plated disc, and TLDP-2 with a 30 mg sintered LiF disc. Construction of dosimeters, their dosimetric properties, instrumentation, and technique of measurements are described. (auth)

351 (LA-DC-72-1144) DESIGN OF ALBEDO-NEUTRON DOSIMETERS. Hankins, Dale E. (Los Alamos Scientific Lab., N. Mex.). 1972. 10p. (CONF-721203-1; SM-167/62). Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

Factors affecting the design of an albedo-neutron dosimetry system using ^{6}Li and ^{7}Li thermoluminescent dosimeters were studied. These factors include energy dependence, sensitivity, orientation with respect to the body, dosimeter-to-body distance, source-to-dosimeter distance, and the presence of shielding materials between the source and the dosimeter. The study did not involve a specific dosimeter design, so the data obtained can be used for most albedo dosimeters. Design variables included incorporation of several thicknesses of polyethylene in the dosimeter, location of the thermal-neutron detectors at nine different positions in or on the dosimeter, and use of differing diameters and thicknesses of cadmium shields in the dosimeters. The results should enable one to design an albedo-neutron dosimeter for his own application or to evaluate a system already in use. The results have been used to design three albedo-neutron dosimeters that are small and completely covered with cadmium; two containing polyethylene; and one that could be used with an automated TLD readout system. A technique has been developed which enables one to determine how variations in neutron spectra at a facility would affect the accuracy of an albedo-neutron dosimetry system prior to its application. This technique utilizes a 3-in. sphere and a 9-in. cadmium-loaded remmeter. It is also used to obtain the calibration factor which should be applied for a particular location or exposure. (auth)

352 IONIZATION IN SOLID- AND GRID-WALLED DETECTORS. Braby, L. A.; Ellett, W. H. (Battelle-Northwest, Richland, Wash.). Contracts N00014-67-A-0369-0006; AT(45-1)-1830. Radiat. Res.; 51: No. 3, 569-80(Sep 1972).

Energy deposition spectra produced in a grid-walled proportional counter are compared to spectra produced in a conventional solid-walled detector. The radiation sources studied include ^{60}Co gamma rays, filtered 250 kVp X rays and unfiltered 250 and 65 kVp X rays. The solid wall is shown to produce significant distortion of the spectra for ^{60}Co gamma rays and filtered 250 kVp X rays but not for the unfiltered X rays. The size of the container housing the grid-walled detector was varied and the wall effect was found to decrease less rapidly with increasing distance between the detector and the wall than would be expected on the basis of geometric considerations. (auth)

353 FAST NEUTRON PERSONNEL MONITORING BY FISSION FRAGMENT REGISTRATION FROM ^{237}Np. Sohrabi, M.; Becker, K. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 104: No. 2, 409-11(1972).

A combination of ^{237}Np ($\approx$3 mg/cm^2) and a polycarbonate foil, to be spark-counted after etching, is used for fast neutron dosimetry between $\approx 10^{-3}$ and >10 rad. (auth)

354 RESPONSE OF ^{6}LiF AND ^{7}LiF THERMOLUMINESCENCE DOSIMETERS TO FAST NEUTRONS. Furuta, Y.; Tanaka, S. (Japan Atomic Energy Research Inst., Tokai). Nucl. Instrum. Methods; 104: No. 2, 365-74(1972).

Energy responses of the integral thermoluminescence of magnesium-activated ^{6}LiF and ^{7}LiF thermoluminescence dosimeters (TLD) were obtained experimentally to neutrons of energies from 17 keV to 14 MeV with ^{60}Co equivalence in roentgens; the responses were compared with the calculated values of the kerma. Glow curves of the TLD's to neutrons were also studied, thereby revealing several facts. (auth)

355 DETERMINATION AND PROPAGATION OF THE DOSE ENERGY UNIT RAD FOR BETA RADIATION BY THE DAMW. PART II. DESIGN AND MODE OF OPERATION OF THE SCINTILLATION-SPECTROMETRIC UNIT AND OF THE FLAT-TYPE IONIZATION CHAMBERS. Guehne, F.; Helmstaedter (Deutsches Amt fuer Messwesen und Warenpruefung, Berlin). Isotopenpraxis; 8: No. 3, 88-94(Mar 1972). (In German).

In addition to the description of the extrapolation chamber and the irradiation plant presented in the first part of this report, the second part supplies a description of the scintillation-spectrometric method and the flat-type ionization chambers used as secondary standards. Like the former units, they are part of the standard measuring equipment of the DAMW used for the determination and propagation of the dose energy unit "rad" for beta radiation. The scintillation-spectrometric method renders possible determination of rad values ranging from 1 up to 500 mrad/h, i.e., within the range, which is essential for health physics, thus providing a valuable supplement of extrapolation chambers. Four flat ionization chambers with variable measuring volume of simple construction and low cost are described for secondary standard dose measurements in the range from 1 mrad/h to 10^5 rad/h. (auth)

356 ENVIRONMENTAL MONITORING WITH TLD. Becker, K. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods; 104: No. 2, 405-7(1972).

$CaSO_4$:Dy has advantages for environmental TLD: It can easily be prepared, is $\approx$30 times as sensitive as LiF:Mg, Ti, and exhibits considerably less fading than previously used CaF_2:Dy. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 2181.

357 (HASL-258) IN SITU Ge(Li) AND NaI(Tl) GAMMA-RAY SPECTROMETRY. Beck, H. L.; DeCampo, J.; Gogolak, C. (Health and Safety Lab., (AEC), New York). Sep 1972. 75p. Dep. NTIS.

The use of large NaI(Tl) crystals and large Ge(Li) diodes to make in situ measurements of γ-rays from sources in the soil and air is described. Methods for inferring source concentrations and contributions to the total exposure rate from individual emitters are discussed and tables of photon flux to source activity and flux to exposure rate conversion factors are presented. Descriptions are given of the calibration of 4 in. by 4 in. NaI(Tl) detectors, and 25 cm^3 and 60 cm^3 Ge(Li) diodes. A number of applications of field spectrometry are discussed. (auth)

358 (ORNL-tr-2610) ELECTROSTATIC SPECTROMETERS. PART II. Allard, P.; Carette, J.-D. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Can. J. Phys.; 49: 2132-7(1971). 13p. Dep. NTIS.

Results of measurements to verify the conclusions of a study concerning the cylindrical condenser used as an electrostatic electron spectrometer are presented. The measurements are related to the angular electron distribution at the exit of the spectrometer, to the average value of the electron energy as a function of the exit angle, to the method of measuring the whole energy distribution of transmitted electrons, and, finally, to the linearity of the transmission characteristics of this spectrometer. (auth)

359 (RD/B/N-2115) USE OF ^{133}Ba AND ^{226}Ra AS MULTI-PEAK SOURCES FOR THE RAPID CALIBRATION OF A Ge(Li) γ-RAY SPECTROMETER. Reed, D.; Ramsdale, J. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 15p. Dep. NTIS (U.S. Sales Only).

A method is described for the rapid and precise calibration of a high resolution Ge(Li) γ-ray spectrometer incorporating a detector of 24 cm^3 active volume. Absolutely standardized multi-

photopeak sources of ^{133}Ba and ^{226}Ra were used to measure full energy peak (F.E.P.) counting efficiencies over the spectral range 30 to 1800 keV for source-to-detector distances spanning 7 to 30 cm. (auth)

360 (RD/B/N-2200) USE OF A COMPUTER PROGRAM FOR THE RAPID ANALYSIS OF Ge(Li) γ-RAY SPECTRAL DATA. Reed, D.; Ramsdale, J. K. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1972. 15p. Dep. NTIS (U. S. Sales Only).

A version of the FORTRAN IV computer program SAMPO was used to analyze large quantities of complex Ge(Li) γ-ray spectral data. A general description of the code and a user's guide is included. There is good agreement between computed and manually processed results. (auth)

361 CURRENT STABILIZER FOR THE ELECTROMAGNET OF A NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Romanov, B. S. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 168-9(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 147-8(1972).

A current stabilizer for the electromagnet in an NMR installation is described in which a composite transistor is used as the control element and a vacuum-tube amplifier is used for feedback. The instability at a current of 0.44 A is $<6 \cdot 10^{-5}$. (auth)

362 MAGNETIC PRISM BETA-RAY SPECTROMETERS: A REVIEW. Peregood, B. P. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods; 104: No. 2, 343-63(1972).

The theory, design and spectroscopic characteristics of magnetic beta-ray spectrometers with the electron optical arrangement identical to that of light optical spectrometers are reviewed. Ways for refinement of such instruments are discussed. (auth)

363 PRODUCTION OF AZIMUTH-DEPENDENT MAGNETIC FIELDS FOR beta-RAY SPECTROMETERS WITH IRON-FREE COILS. Daniel, H.; Deimel, P. (Technical Univ., Munich). Nucl. Instrum. Methods; 104: No. 2, 403-4(1972).

An iron-free coil setup for the production of azimuth-dependent magnetic fields for "flat" β-ray spectrometers with stationary orbit is proposed. The azimuthal variation of the cos θ type is obtained by using two coil systems each producing identical azimuth-independent fields around their axes, and by putting the two systems with coinciding symmetry planes and antiparallel axes a small distance apart. (auth)

364 FACILITY FOR THE STUDY OF (n,x)-REACTIONS USING AN ISOCHRONOUS CYCLOTRON. Kropp, L.; Forti, P. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 104: No. 2, 381-91(1972).

A time-of-flight apparatus for the measurement of neutron induced differential reaction cross sections over a wide continuous neutron energy range from a few MeV to about 30 MeV is described. Silicon semiconductor detector telescopes are used to determine the energy and the kind of charged particles emitted at different reaction angles. The neutron energy is determined by time-of-flight. The characteristic features of the solid state detector telescope system are given. Angular distributions for the $^{9}Be(n,\alpha_0)$ and $^{9}Be(n,\alpha_1)$ reaction are given for 18 energies between 11 and 30 MeV. Differential $^{9}Be(n,\alpha)$ excitation functions are given for 6 angles between 20° and 140° as a function of neutron energy between 8 and 30 MeV. (auth)

365 DEVICE FOR INVESTIGATING NUCLEAR γ RESONANCE SCATTERING USING RABBITS. Kaipov, D. K.; Kosyak, Yu. G.; Smirin, L. N.; Shubnyi, Yu. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 25-9(Jul-Aug 1971). (In Russian).

An arrangement has been constructed for studying nuclear γ resonance scattering, in which a 5-Ci short-lived source isotope is employed in liquid and solid phases. The elementary parameters are discussed, and the method of measurement and treatment of the experimental data is outlined. (tr-auth)

366 β SPECTROMETER WITH Si(Li) DETECTOR AND SUPERCONDUCTING MAGNET. Morozov, V. I.; Pelekov, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 631-5(Mar 1972). (In Russian).

A spectrometer was designed with a superconducting solenoidal magnet and a silicon detector for studying electron spectra in radioactive decay. The 22.8 cm solenoid was wound with a Cu-plated alloy of Nb-50% Zr, and was cooled to the temperature of liquid He. The measurement of the beta spectrum from a ^{137}Cs–^{207}Bi source is described for the purpose of illustrating the possibilities of the instrument. (K.S.W.)

High Energy Physics Instrumentation

367 (ANL/HEP-7243) ARGONNE EFFECTIVE MASS SPECTROMETER FACILITY. Diebold, R. (Argonne National Lab., Ill.). Sep 1972. 3p. Dep. NTIS.

The facility consists of a large aperture magnet surrounded by magnetostrictive wire spark chambers and associated equipment. The beam supplied to the facility is unseparated with maximum momentum 6 GeV/c. A six counter hodoscope at the first focus tags the momentum to ±0.2% and four threshold Cherenkov counters identify the beam particles as fast (π, μ, e), K, or proton. A maximum of 200,000 beam particles per 0.7-sec spill passes through the apparatus, with special gating to avoid extra beam tracks. The counter and spark chamber information is read into an EMR-6050 computer. (W.H.K.)

368 (BNL-17209) MULTIPARTICLE SPECTROMETER MAGNET (MPS). Halik, Eugene E. (Brookhaven National Lab., Upton, N. Y.). [nd]. 5p. (CONF-720908-2). Dep. NTIS.

From 4th international conference on magnet technology; Upton, NY. (19 Sep 1972).

During the last few years more and more Spectrometer Magnets were employed in high energy physics experiments. Most of these experiments detected a relatively small number of particle secondaries because the apertures of the magnets were not satisfactorily large. For this reason an attempt is being made at BNL to build a spectrometer which could accommodate experiments on more complicated types of interactions with detection of many secondaries. Obviously this spectrometer, in order to perform properly, will be large and with an acceptable magnetic field; it must have better resolution, and a wide solid angle acceptance. The basic idea is a large aperture C-magnet. High resolution digitized spark chambers, low mass proportional chambers and scintillation counter hodoscopes will be located and operated within the magnetic field volume which will be 4-ft high by 6-ft wide by 15-ft long. The main spectrometer is to be followed by a set of large digitized spark chambers, scintillation counter hodoscopes, and Cherenkov counter hodoscopes to provide improved momentum resolution and particle identification for those particles which emerge through the downstream aperture of the magnets. This magnet spark chamber combination will give the experimenter freedom to move to a new class of experiments. (auth)

369 VACUUM SEALING OF CRYOGENIC INSTALLATIONS. Beketov, V. A.; Beketov, G. V.; Shatlovskaya, N. S. (Inst. of Theoretical and Experimental Physics, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 259-60(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 221-2(1972).

The method of sealing and the structural features of the combined sealing washers used to seal cryogenic installations, glass illuminators of liquid-hydrogen bubble chambers, and other systems operating under conditions of a high vacuum, variable pressure and temperature, and chemically active media are described. (auth)

370 MULTI-TERMINAL INTERACTIVE GRAPHICS SYSTEM USING A SMALL COMPUTER. Maden, D.; Rosner, R. A. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 104: No. 2, 375-80(1972).

The use of facilities for the visual inspection of events from high energy physics experiments is discussed. The implementation of an interactive display system for spark chamber events is presented in which display terminals incorporating Tektronix 611 storage scopes are connected to a 16k Honeywell DDP 516 computer. System principles and operational experience are described. (auth)

371 SELECTIVE TRIGGERING SYSTEM WITH PROPORTIONAL CHAMBERS FOR THE SMALL ANGLE π−p SCATTERING EXPERIMENT AT 40 AND 50 GeV. Guzik, Z.; Hajduk, Z.; Krasowski, R.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl Instrum. Methods; 104: No. 2, 337-41(1972).

The described system triggers a magnetic spectrometer with magnetostrictive spark chambers when the required conditions of the scattering angle of a particle is satisfied. Six wire proportional chambers are used as detectors for the decision-making analog circuit. The trigger rate averages about 15 when detecting particles scattered for angles greater than 0.5 mrad. About 300 nsec are required for analysing one event. (auth)

372 REVIEW OF BUBBLE CHAMBERS. Huson, F. R. (National Accelerator Lab., Batavia, Ill.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 391-403(1972).

From 3rd international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

This review of bubble chamber technology is done by looking at current experiments being performed and by looking at proposals for future experiments. (auth)

Radiometric Instruments

373 MATHEMATICAL MODEL FOR THE MEASUREMENT OF GAS PROPERTIES WITH ALPHA-PARTICLE GAGES. Gard-

ner, R. P.; Verghese, K.; Cehn, J. I. (North Carolina State Univ., Raleigh). Nucl. Technol.; 16: No. 3, 418-29(Nov 1972).

A mathematical model is developed for predicting the spectra of alpha particles of distributed energy emitted by a point, transmitted through gas mixtures, and detected by a circular detector. Circular sources located coaxially with the detector are also treated. Experimental results verify the accuracy of the model. Possible applications of the model include the calibration and optimum design of all transmission type alpha-particle gauges for specific measurements such as atmospheric densimeters. A new gauging principle based on the alpha particle stopping power is also identified and preliminary experiments indicate its feasibility. This principle consists of using a non-linear search on the amounts of gaseous components present to obtain the best fit between experimental and calculated alpha-particle spectra. If the stopping powers at the different alpha particle energies are different for all components, then, in principle, one can analyze for the amounts of each component. Potential application of this principle to measurements of density (free of composition interferences) and gas composition of planetary atmospheres is discussed. (auth)

374 INDUSTRIAL MEASUREMENT AND CONTROL BY RADIATION TECHNIQUES. International Conference and Exhibition, Guildford, England, April 11–13, 1972. IEE Conference Publication, No. 84. London; Institution of Electrical Engineers (1972). 255p. £8.70. (CONF-720447).

Thirty-eight papers were presented, of which separate abstracts have been prepared for twenty-three. (UK)

For abstracts of individual papers see: 375–397.

375 MEASUREMENT OF STEREOLOGICAL PARAMETERS FOR THE MINERAL INDUSTRY BY A COMPUTER CONTROLLED ELECTRON PROBE X-RAY MICROANALYSER. Jones, M. P.; Beaven, C. H. J.; Shaw, J. L. (Imperial Coll. of Science and Tech., London). pp 1-6 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

In the instrument described, the characteristic x-rays produced from mineral specimens are analyzed to provide chemical and stereological information. The operation of the instrument is controlled by a small computer. Many of the samples examined are very heterogeneous and many square centimeters of specimen section may need to be examined to provide statistically reliable data; the microanalyzer can be programmed to examine these large areas automatically for periods up to 24 hours. Some data reduction is performed by the controlling computer. Examples of the use of this technique are given. (UK)

376 PARTICLE SIZE DETERMINATION BY LIGHT AND BY X-RAY ATTENUATION. Allen, T.; Svarovsky, L. (Bradford Univ., Eng.). pp 7-15 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Two instruments for particle size determination in the subsieve range are described. In both instruments changing concentration with time and depth of fall for sedimenting suspensions is monitored with a beam of radiation. A white light source is used in the wide angle photosedimentometer and an isotope source with the Ladal x-ray sedimentometer. The extension to the submicron range using a disc centrifuge is described for the Ladal. Some illustrative results are tabulated, evaluation methods described and comparison analyses with other techniques presented. (auth)

377 NUCLEONIC COAL SENSOR AS AN ELEMENT OF A CONTROL SYSTEM FOR AUTOMATIC STEERING OF A COAL CUTTER. Addison, G. T.; Edwards, J. B. (National Coal Board, Burton-on-Trent, Eng.). pp 20-9 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

The nucleonic coal sensor comprises a heavily shielded low strength radioisotope source (typically 5 to 50 mc ^{137}Cs) placed about 50 cm from a suitable detector, such as a scintillation crystal and photomultiplier, and having a vertically collimated beam. This whole unit is positioned up to 1.5 meters behind the coal cutting drum, in close contact with either the cut roof or floor. Back-scattered radiation through the layer of coal left by the drum increases with increasing thickness of the layer up to a saturation level, thus providing, via a ratemeter, a feedback signal for an automatic steering system. Unfortunately, from the control aspect, permissible radiation levels on the coal face restrict isotope strengths, and hence output pulse rates, to relatively low values, thus requiring a substantial ratemeter time constant for the smoothing of the coal thickness signal. For a given type and strength of isotope the range of the sensor is largely determined by source/detector separation. Considerable interest is being shown in evaluating the feasibility of siting such a coal sensor within the rotating cutting drum; this poses considerable electronic and mechanical engineering problems. Amongst matters discussed is the effect of nucleonic noise on system performance, and a simple model is presented for a noise-free steering system. The use of digital and analog systems is also discussed. It is concluded that the effects of nucleonic noise are tolerable, but digital filtering should be explored in more detail. (UK)

378 COMPUTER-BASED SYSTEM FOR SHEET AND COATING THICKNESS MEASUREMENT. Kowalski, E. (Landis und Gyr A.G., Zug, Switzerland). pp 30-7 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Analog and digital signal processing are compared for process control systems, with particular regard to complexity of operations. Below a certain complexity level the analog system is more economic, but above this level the use of a digital system offers advantages. A mini-computer based system is described for sheet, pipe wall and coating thickness radioisotopic measurement and control that allows the complexity level to be lowered to such an extent that the use of a digital system becomes justified even for simple measuring installations. This system is referred to by the trade name MEMOGYR, and main characteristics of the system are described. (UK)

379 CONTROL ANALYSIS AT BRITISH STEEL CORPORATION, PORT TALBOT WORKS BY EMISSION AND X-RAY FLUORESCENCE SPECTROSCOPY. Gwilliam, L. (British Steel Corp., Port Talbot, Wales). pp 54-8 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

With the introduction of newer steel making processes it has become necessary to establish much better analytical control of the raw materials supplied to the processes leading to the production of sheet steel. In this connection conventional chemical methods are much too slow and much effort has been applied to the development of emission and x-ray fluorescence spectroscopic methods for the purpose. The x-ray technique used at Port Talbot is described in detail. In order to provide the speed and accuracy of analysis required for iron and steel analysis rapid methods of sampling have been developed, designed for analysis by direct reading emission spectroscopy, and the method employed, using a Vacuum Direct Reading Emission Spectrometer, is also described. Costs are briefly considered, and further improvements to the techniques are indicated. (UK)

380 ON-LINE MEASUREMENT AND CONTROL OF CONTINUOUS TIN AND ZINC COATING LINES BY RADIOISOTOPE X-RAY FLUORESCENCE TECHNIQUES. Cameron, J. F. (Nuclear Enterprises Ltd., Reading, Eng.). pp 72-7 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Close control of coating thickness is necessary to meet customer specifications, and in order to produce a product within specification the manufacturer requires an accurate and reliable on-line gage. The use of a well designed on-line gage, with a data processing and control system, may result in a saving of many thousands of pounds per annum in regard to consumption of materials. All modern Sn and Zn coating thickness gages are based on x-ray fluorescence techniques, and a description is given of types of x-ray fluorescence gages used. Gages using bremsstrahlung sources are still in routine use, but on-line gages had to await the development of a suitable radioisotope source (^{241}Am). Compared with electrical primary x-ray generators radioisotope sources have the advantages of compactness, freedom from maintenance and the need for high voltage supplies, constant energy and intensity, and low price. Details are given of the technique

employed using radioisotope sources, and of on-line measurement and control with these instruments. (UK)

381 NONDESTRUCTIVE THICKNESS MEASUREMENT OF INSIDE AND OUTSIDE COATINGS OF ALUMINIUM TUBES. Roetzer, H.; Markowitsch, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). pp 83-8 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Aluminum tubes for food, pharmaceutical and cosmetic products need to be protected, inside and outside, against corrosion by thin layers of varnish. These layers should not be too thick, since the risk of peeling off would arise, and costs would be increased. Until recently chemical methods were employed to assess coating thickness, necessitating destruction of samples of the tube and involving much time. The present paper describes the use of a device based on x-ray fluorescence for measurement of inside and outside coatings, the techniques for which are rather different. The apparatus used is described; both measurements can be made with one measuring head. A Cu foil with a Zr layer, deposited by evaporation and impregnated with T, is used as source. The 18-keV β-radiation of the T is completely absorbed in the Zr layer which, in turn, emits a continuous bremsstrahlung spectrum superimposed by the L-line of Zr with an energy of about 2.3 keV. (UK)

382 GAMMA-RAY-BACKSCATTER GAUGES FOR MEASURING COAL THICKNESS ON MECHANISED COALFACES. Cooper, L. R. (National Coal Board, Burton-on-Trent, Eng.). pp 89-93 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

A basic requirement of automatically steered coal mining machines is an instrument to measure the position of the machine in the coal seam. This position may be defined as the distance between the upper (or lower) cutting edge of the machine and the corresponding upper (or lower) limit of the seam. It is possible to position a probe immediately behind the cutting picks so that the thickness of coal left by the picks is measured. The conditions under which such a probe must operate are very arduous; the mounting, being the cutting machine itself, is often subject to intense vibration, and the air is thick with dust and very humid. Nevertheless three types of γ-ray backscatter probes have been designed for the purpose and used successfully in mines. Details are given of these probes and their method of use. (UK)

383 USE OF AN IN-STREAM HEAD FOR THE X-RAY FLUORESCENCE ANALYSIS OF SLURRIES. Williams, A. W.; Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). pp 94-102 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

An in-stream sensing head has been developed which runs completely immersed in a slurry stream instead of slurry flowing through the analyzer. A balanced filter system, employing x-ray fluorescence, is used to determine an element (initially copper). The density of the slurry is measured simultaneously by γ transmission. The performance, both in a launder and slurry pipe, using differing solid contents and concentrations of copper, is described as well as such factors as its ability to withstand wear. Segregation and deposition of solids on the sensor window are also discussed. (auth)

384 ON-STREAM APPLICATION OF SEMICONDUCTOR X-RAY DETECTORS. Carr-Brion, K. G. (Warren Spring Lab., Stevenage, Eng.). pp 103-7 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

The mode of operation of semiconductor x-ray detectors is briefly outlined and relevant aspects of their performance discussed. The advantages and disadvantages of using semiconductor detectors with sources comprising low-power x-ray tubes for on-stream analysis are examined. These include factors such as ease of sample presentation, stability, microphonic sensitivity and selection of exciting x-ray energy. Finally, a number of applications and feasibility studies are described, including applications in the cement, mineral processing, extractive metallurgy and other industries. (auth)

385 ON-LINE MEASUREMENT OF SULPHUR CONTENT OF LIQUID HYDROCARBONS BY X-RAY ABSORPTION TECHNIQUES. Cameron, J. F.; Piper, D. G. (Nuclear Enterprises Ltd., Reading, Eng.). pp 108-12 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

In order to meet customer and statutory specifications for S content of petroleum products, rapid and accurate analyses are required. At the present time the majority of on-stream S monitors are based on the absorption of x-rays emitted from radioisotope sources: such sources are compact and inexpensive, and their radiation energy and intensity are stable. The principles of the method are stated, together with a summary of errors in measuring S by x-ray absorption techniques, and a review of on-stream monitors. The first on-stream S monitors used $^{3}H/Zr$ bremsstrahlung sources and were applied to products in which variations in specific gravity and C : H ratio were small. With the development of $^{147}Pm/Zr$ bremsstrahlung sources, having a mean energy of about 22 keV, instruments were developed that were sensibly independent of C : H ratio variations and, by using a constant sample mass, were also made independent of density variations. These instruments give a precision of about 0.02% S by weight and are in routine use on products ranging from fuel oils to gasoline. Monitors using ^{241}Am secondary emission sources of 22 keV to overcome variations in C : H ratio and that either make a separate measurement of density and appropriate corrections, or use a constant mass of sample, have also been developed. (UK)

386 ANALYTICAL CONTROL OF RAW MATERIAL FOR DECIMAL COINAGE WITH AN X-RAY FLUORESCENCE SPECTROMETER AND DIGITAL COMPUTER. Sanger, T. R.; Watson, I. pp 113-21 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

In connection with the manufacture of the new decimal coinage in the UK, contractors were required to produce blanks of various gages and diameters in the two coinage alloys bronze and cupronickel. Alloy analysis was performed with an x-ray fluorescence spectrometer, and had to be accurate and reproducible in order to show whether the material was within specification. It also had to be rapid, with an individual analysis time of about 1 min, and a capability of automatically handling up to 200 blanks without human intervention. The instrument employed is described, together with its associated computer and software and mechanical handling system. (UK)

387 MEASUREMENT ON-LINE OF CARBON FIBRE MODULUS USING POSITION SENSING X-RAY COUNTERS. Owen, R. B.; Smout, D. W. S. (UKAEA Research Group, Harwell, Eng.). pp 122-9 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Carbon fibers are produced with a preferred orientation, with the C-axis of the graphite normal to the fiber axis, that is, with the principal graphite planes parallel to the fiber, and Young's modulus appears to be closely related to the degree of orientation of the crystallites. X-ray diffraction using Cu Kα radiation incident normal to the axis of a fully oriented fiber will produce two bright spots from crystallites where the Bragg condition is met. If the crystallites are not fully oriented these spots broaden into arcs of a circle in the plane normal to the x-ray beam, whose radius subtends 26.5° at the specimen, and on which the scattered x rays have a Gaussian intensity distribution. The Young's modulus of a fiber has been found to be related to the angular half-width of the diffracted Gaussian intensity distribution. Equipment is described designed to obtain a rapid measurement of the standard deviation of the intensity distribution and provide an on-line measurement of any change in crystallite orientation and fiber modulus. This equipment makes use of position sensing proportional counter systems. The counter has a cylindrical Be body, 2.54 cm in diameter, with a wall thickness of 0.254 mm over a length of 10 cm. Alumina seals are brazed on to each end, and the filling gas is Xe. Charge integrating amplifiers are connected to each end of the resistive control electrode. Both laboratory tests and experience on a carbon fiber plant at AERE, Harwell, are described. (UK)

388 MEASURING THE THICKNESS OF THE ZINC COATING ON CONTINUOUSLY GALVANIZED STEEL SHEET. Gruber, U. (Landis und Gyr A.G.; Zug, Switzerland). pp 136-42 of

Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Measurement of the thickness of Zn layer can be carried out by backscattered β-radiation, but better precision is achieved by using the x-ray fluorescence technique, whereby it is possible to determine the Zn coating with an accuracy of a few ten-thousandths of a mm. Details are given of both methods of measurement. Advantages of integrating a minicomputer into the measuring system are described, and details are given of the measuring system known as MEMOGYR, employing a digital minicomputer. Comparisons are made between the use of analog and computer-based systems, and the superiority of the computer based measuring system is demonstrated. (UK)

389 X-RAY AND NUCLEAR TECHNIQUES FOR THICKNESS MEASUREMENT IN STRIP METAL ROLLING. Perriam, L. T. (Daystrom, Gloucester, Eng.). pp 153-8 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

The use of thickness measuring beams of x- or isotope radiation for metal strip or foil during its fabrication from ingots is described. These techniques avoid damage caused by thickness measuring contacts such as micrometers. Special gage requirements for individual purposes are mentioned. Isotope sources have developed from the use of β-sources such as Tl and ^{90}Sr, through bremsstrahlung sources, to ^{241}Am. Brief technical and equipment specifications are given, including computer and manual control of gages. (UK)

390 RADIOMETRIC THICKNESS AND DENSITY MEASUREMENT. Polly, P. (Ludwig Krohne KG, Duisburg, Ger.). pp 191-6 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

In many cases the use of nuclear radiation gages has resulted in great improvements in accuracy of measurements, and in some cases only such gages made the measurement of important process parameters possible. Such gages also provide economic savings. A description is given of nuclear density gages, that are employed for measuring the density of liquids flowing in pipes, and of nuclear thickness gages, employed for the measurement of thickness or area weight of plates, sheets and similar plane materials. Examples are given of the numerous applications of nuclear gaging. Beta- or high energy γ-sources may be used. (UK)

391 SOME USES OF NEUTRONS FOR ANALYTICAL CONTROL. Pierce, T. B. (UKAEA Research Group, Harwell, Eng.). pp 197-207 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

A number of different techniques are available, based on the interaction of neutrons with matter, that can be employed to provide useful information on the composition and properties of materials examined. One of the practical advantages of neutron techniques is that both neutrons, and also the γ-radiation that frequently results from their interaction with matter, are penetrating radiations. This permits information to be obtained from relatively large samples, which is of value when the sample is inhomogeneous or an analytical figure is required that is representative of a large bulk of material. Preparation of samples for automatic analyzers can be simple, and continuous analyzers can often be designed without the need for thin counter windows. Neutron techniques consequently can present considerable attraction for analytical control where reduction in analytical effort is desirable, and neutron devices can sometimes be directly incorporated into on-line sensors. Some of the methods for analytical control that have been developed and used at AERE, Harwell are described under the following headings: Methods based on the measurement of primary radiation (neutron transmission; neutron scattering; neutron moderation), methods based on the measurement of secondary radiation (induced radioactivity; neutron capture; inelastic neutron scattering; recoil techniques). Equipment needed is described. Amongst applications described are: neutron transmission for determination of B; determination of moisture by proton recoil; and the determination of O and F by fast neutron activation. (UK)

392 ON-LINE NON-CONTACTING DETERMINATION OF ASH CONTENT IN FAST MOVING PAPER WEBS. Frevert, E.; Steidl, J. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). pp 208-14 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

A description is given of the development and construction of equipment for the on-line determination of the ash content in fast moving paper webs. The measuring method is based on the back scattering of low energy γ-rays from a ^{55}Fe source. Tests at a paper mill gave excellent results. As the ^{55}Fe source has a half-life of only 2.7 yr its decrease in intensity has to be continuously corrected in order to maintain accurate measurements. (UK)

393 CONTINUOUS NON-CONTACTING MOISTURE GAUGING OF SINTER ORES ON CONVEYOR BELTS, IRRESPECTIVE OF LAYER THICKNESS AND MATERIAL MIXTURE. Frevert, E.; Stehno, G. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). pp 215-21 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Equipment is described that was developed to determine the moisture content of sinter ores directly on conveyor belts. High energy neutrons are transmitted through the material being examined, and the thermalized neutrons, slowed down by the H-atoms, are measured. The absorption of γ-rays is simultaneously measured. By combining these values it was found possible to determine moisture independent of layer thickness and material. Two steel sinter ore mixtures and one haematite mixture were used in the tests. With a moisture content of 6% by weight and a measuring time of 10 sec the accuracy was to within 0.3 to 0.5% by weight. Details are given of laboratory tests. (UK)

394 METHODS OF IMPROVING ACCURACY IN THE X-RAY FLUORESCENCE ANALYSIS OF MINERAL MATERIALS. Ball, P. J.; Coster, J. N.; Starnes, P. E. pp 222-7 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

While x-ray fluorescence techniques have been very successfully applied to the analysis of homogeneous samples, difficulties are encountered when attempting to analyze natural materials, because of their variable and heterogeneous constitution. These difficulties arise particularly with mineral processing pulps, which exhibit wide variations in particle size, host grain mineralogy, and overall matrix composition; these significantly affect the relationship between sought element concentration and fluorescent x-ray intensity. It has been found that it is generally possible to describe the properties of an aqueous mineral slurry or pulp by two parameters, referred to as the effective matrix constant and the heterogeneity factor. Both parameters influence the emitted fluorescent intensity by affecting absorption of the primary incoming and the secondary outgoing radiation, but they are distinguished by the fact that whilst the effective matrix constant changes with dilution of the sample, the heterogeneity factor remains unaffected, since it relates to the micro-environment of the fluorescing atoms in the host grains. In pulps having low sought element concentrations, such as concentrator tailings, variations in host grain mineralogy can exert a considerable effect on fluorescent x-ray intensity without producing any detectable change in the matrix value as determined by conventional radiation backscatter and transmission measurements. Hence it has often proved impossible to achieve satisfactory accuracy when analyzing process streams of varying mineralogy. Each of the parameters mentioned is a function of both grain size and composition. A general technique has been devised to measure effective matrix constant directly. In the case of the heterogeneity factor a method of determination has been developed, that was found to be applicable in at least one case of practical importance. The case of Cu concentrators working with mixed sulphide/oxide ores is discussed in detail. (UK)

395 APPLICATION OF RADIOISOTOPES TO THE MEASUREMENT AND CONTROL OF STRIP THICKNESS IN THE STEEL INDUSTRY. Boyle, P. W. (Boyle Industrial Gauging Systems Ltd., Northfleet, Eng.). pp 232-7 of Industrial Measure-

ment and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

Equipment is described whereby the thickness of steel strip produced by a rolling mill running at up to 2,000 meters a minute can be continuously measured. For this purpose radioisotope gages are used having a measuring head with a measuring gap of approximately 500mm. The gages incorporate integrated circuitry and are computer interfaced at input and output. It was necessary to pay particular attention to the radioactive source statistics (241 Am), the source-detector geometry, detector efficiency, input resistor thermal drift, electronic drift, and linearizing arrangements. These are in turn discussed. The gages described have been running in continuous service for a year and are meeting requirements in every way. (UK)

396 APPLICATION OF MOISTURE DETERMINATION IN PARTICULATE SOLIDS BY NEUTRON MODERATION TECHNIQUES TO IRON ORE PREPARATION AND IRON MAKING. Jones, L. M.; Pritchard, W. D. N,. Williams, K. F.; Williams, R. B. (British Steel Corp., Port Talbot, Wales). pp 238-51 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

In iron ore preparation and in iron making it is desirable to measure the moisture content of a number of particulate solids, and especially those in sinter mix and coke charged to a blast furnace. Techniques for moisture determination were reviewed and it was finally decided that the neutron moderation technique had the best chance of success. The principle of neutron moderation by hydrogen is outlined, and the different types of neutron moisture gages required are considered in relation to substances to be examined, control requirements, and type and size of plant engineering. Where practicable it is desirable to surround the neutron source and detector completely by the sample, in order to obtain the greatest signal. A common fast neutron source is ^{241}Am mixed with Be. Details are given for the application of the technique for moisture determination in blast furnace coke, and for moisture in sinter mix. Coupling with control systems, and continuous measurement, and advances in applications are discussed. (UK)

397 CROSSWELD MARKING BY FAST NEUTRON ACTIVATION. Gill, C. H. pp 252-5 of Industrial Measurement and Control by Radiation Techniques. London; Institution of Electrical Engineers (1972).

From International conference on industrial measurement and control by radiation techniques and exhibition; Guildford, England (11 Apr 1972). See CONF-720447.

The process of continuous steel tube manufacture requires that coils of flat strip steel are joined together to form a continuous strip that is fed through furnaces and rollers to form the tube. Flash welding is normally used for the joining operation, and after the further heat treatment and mechanical forming operations which are employed it is difficult to distinguish the weld locations visually; it is essential that the welds are detected, as they form potentially weak zones that could fail under mechanical load conditions. Trials were made of fast neutron activation for this purpose, using the reaction $^{56}Fe(n,p)^{56}Mn$. Manganese-56 emits γ-rays of energies 0.845, 1.8 and 2.12 MeV, and thus by irradiating the steel strip it is possible to detect weld positions with a suitable γ-detector, such as a NaI scintillation crystal coupled to a photomultiplier and ratemeter. The ratemeter output can be used to initiate a mechanical system to cut out and reject weak portions of the tube. The nuclear reaction involved has a threshold at ~5 MeV, and hence it is essential to use neutrons of greater energy. A prolific source of such neutrons is the DT reaction in which D-ions are accelerated onto a T loaded target by a potential in excess of 100 kV. A requirement is that the neutron source must be capable of being switched on and off, as irradiation is only required when the strip is being welded; this rules out the use of an isotope neutron source. Some trials are described, and it was found that a neutron output of 5×10^9 n/sec. is necessary to meet the requirement of a 10 sec. irradiation time. Suitable positioning of the neutron generator is discussed. (UK)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstract 404.

398 (BDX-613-690) HIGH-DENSITY BRAID CABLE SHIELDS, FY72-3. Quarterly Report. Galbraith, J. F. (Bendix Corp., Kansas City, Mo.). Jun 1972. Contract AT(29-1)-613. 15p. Dep. NTIS.

The development of processes and tools to braid small diameter wire strands onto cable assemblies for two weapons programs and to electrically terminate the braid is described. The high-density wire is being applied for a protective shield against electromagnetic radiation. (W.D.K.)

399 NATURE OF THE RADIATION CURRENT AND THE CHOICE OF THE OPTIMAL DIMENSIONS OF THE ENTRY CHAMBER OF PHOTOMULTIPLIERS OPERATING IN GAMMA-FIELDS. Nguyen Kuang, Minh; Lutsko, A. M.; Pertsev, A. N. (Belorussian State Univ., Minsk). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 190-3(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 165-7(1972).

Calculated and experimental results are presented which are evidence of the leading contribution of Compton electrons formed in the glass of the entry chamber of a photomultiplier to the photomultiplier radiation current which develops when photomultipliers are irradiated by γ-fields. The magnitude of the radiation current depends on the dimensions of the entry chamber and can be minimized when the height of the entry chamber is equal to its radius. (auth)

400 RADIATION EFFECTS ON AN ALL-THIN-FILM AMORPHOUS MEMORY DEVICE. Smith, R. A.; Sanford, R.; Warnock, F. E. (Naval Ordnance Lab., Silver Spring, Md.). J. Non-Cryst. Solids; 8-10: 862-7(Jun 1972).

The all-thin-film amorphous memory element, with its improved mechanical stability, has provided a much more acceptable vehicle on which to study radiation effects. Results of a study of the effects of 10^{16} neutrons/cm^2 (e > 10 keV) and 3.3×10^7 R of fission gamma rays on memory elements structured on silicon substrates are summarized. (auth)

401 EFFECTS OF CHEMICAL IMPURITIES ON THE RADIATION DAMAGE CONSTANT OF SILICON SOLAR CELLS. Usami, Akira (Nagoya Inst. of Tech., Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 528-33(Sep 1972).

The modified damage constant, $K_L = (1/L_1^2 - 1/L_0^2) \cdot \phi^{-1}$, is obtained from the drop rate of the photocurrent at 1.0 μm monochromatic light irradiation, where the minority carrier diffusion length in the bulk region before γ-irradiation, L_0, is estimated by fitting the observed spectral response curve to those calculated with the diffusion length as parameter. The values L_1 and ϕ represent the minority carrier diffusion length after γ-irradiation, and the total flux of incident γ-ray photons, respectively. When N/P-type cells are contaminated with Cu, the values of K_L are smaller by about one order of magnitude compared with non-doped cells, while those of the P/N-type cell contaminated with either Cu or Ni are only slightly smaller than when not doped. The K_L values of the pulled (C · Z) bulk P/N-type cell are about ½ those of the floating zone (F · Z) bulk cell. The curves of K_L of the non-doped F · Z and C · Z bulk P/N-type cell vs. total dosage begin to decrease from a point below 10^{16} photons/cm^2 total dose. Also, the damage constant, $K = (\tau_1^{-1} - \tau_0^{-1}) \cdot \phi^{-1}$, of n-type floating zone (F · Z) and pulled (C · Z) bulk P/N-type cells and of p-type C · Z bulk N/P-type cells, both γ-irradiated, is seen to increase with dopant concentration in the bulk region. (auth)

402 TEMPERATURE-INSENSITIVE AMORPHOUS THIN-FILM DEVICES, INCLUDING NEUTRON IRRADIATION STUDIES. Nicolaides, R. Vogel; Doremus, L. William (Picatinny Arsenal, Dover, N. J.). J. Non-Cryst. Solids; 8-10: 857-61(Jun 1972).

Thin-film memory devices were prepared by evaporation of doped As_2Se_2Te to form sandwich-type devices with Al electrodes. The threshold voltage, on-state and off-state properties are independent of temperature over a broad temperature range. The threshold voltage varies as little as 5% between –30°C and +135°C. The off-state current voltage curve has a distinct voltage limiting behavior over the lower part of this temperature range including room temperature. Measured switching and memory characteristics of doped and undoped devices, subjected to neutron irradiation up to 10^{15} n/cm^2 (>10 keV), were not affected in most instances. (auth)

Miscellaneous Instruments

Refer also to abstracts 343, 1952, 1973, and 2227.

403 (RISO-M-1509) ELECTRONICS DEPARTMENT SEMI-ANNUAL REPORT FOR THE PERIOD 1 OCTOBER 1971–31 MARCH 1972. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 27p. Dep. NTIS (U. S. Sales Only).

A review is given of the development of instrumentation for Risø experiments, research in system techniques and nuclear geophysical methods, and work in the service area. Publications issued during the half-year period are listed. (auth)

404 (SC-DR-720525) EMR 6130 (DADS SYSTEM II) ON-LINE STATION: RADIATION EFFECTS SEMICONDUCTOR TESTER. Longerot, C. D. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 28p. Dep. NTIS.

One of several on-line laboratory stations connected to the real-time/time-share EMR 6130 centralized computer is described. The test station described allows real-time data acquisition and display in support of semiconductor radiation effects studies through the use of a programmable test controller and graphic display terminal. (auth)

405 ATTENUATION OF MODULATION NOISE IN A NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Shpin'kov, N. I. (Moscow State Univ.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 149-51(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 133-4(1972).

Using feedback, which is sensitive to variations of the amplitude and phase of the modulating field, the modulation current is stabilized, and this lowers the noise level. Under these conditions the sensitivity of an autodyne NMR spectrometer for broad lines allows resonance from 17 mg of metallic vanadium in a field H = 10 kOe at room temperature for a space factor $\xi = 4 \cdot 10^{-3}$ to be recorded with a signal-to-noise ratio equal to 10. (auth)

406 SENSITIVITY OF NUCLEAR MAGNETIC RESONANCE SIGNAL PICKUPS HAVING A LOW RESOLUTION. Amiton, I. P.; Zavel'skii, V. O.; Fedin, E. I. (Inst. of Elemento-Organic Compounds, Moscow). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 147-8(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 131-3(1972).

The circuit of an autodyne having a high sensitivity to NMR signals is described. A stiff oscillation mode increases the sensitivity by a factor of 10 to 15. A compact autodyne construction is proposed and tested, which ensures approximately a two-fold increase in the space factor. (auth)

407 ELECTRICAL PROPERTIES OF BISTABLE NIOBIUM PENTOXIDE FILMS. Herrell, D. J.; Park, K. C. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Non-Cryst. Solids; 8-10: 449-54(Jun 1972).

Current, voltage, temperature (I–V–T) and conductance, voltage, temperature (G–V–T) as well as switching time measurements were made on the switching states of bistable amorphous niobium pentoxide films. The measurements are indicative of a charge transfer mechanism occurring prior to switching. I–V–T and G–V–T measurements on the switching states for temperatures in the range 1.3 to 4.2°K as well as at 77 and 300°K are discussed. (auth)

408 NEW APPROACH TO X-RAY SHIELDING OF THE VIEWING HEAD OF AN ELECTRON MICROSCOPE. Egle, W. Optik; 35: No. 3, 296-300(1972). (In German).

The shielding for parasitic x radiation at the viewing chamber and the camera chamber of an electron microscope must be designed to provide full protection even under extreme operating conditions. A new protective system which reduces the shielding problem to ordinary electron-microscopic operating conditions is described. The x-ray dose involved is several orders of magnitude smaller than under extreme conditions and thus makes shielding less of a problem. When the admissible x-ray dose is exceeded, the protective system consisting of an x-ray detector and an electronic amplifier unit cuts off the accelerating voltage, thus preventing the generation of further x radiation. Contrary to passive shielding, this method has no upper limit in regard to gamma quantum energy. (GF)

409 DESIGN AND CONSTRUCTION OF A HIGH TEMPERATURE LIQUID METAL SOLUTION CALORIMETER. Vieth, Donald Louis. Cincinnati; Univ. of Cincinnati (1972). 128p. University Microfilms Order No. 72-23,593.

Thesis.

The design consideration and calibration of a new single well liquid metal solution calorimeter for use at high temperature is described. The calorimeter has an operational temperature range of 500 to 1300°C in a vacuum environment of 2.67×10^{-4} Pa (2×10^{-6} torr). It was designed primarily to operate at 1200°C using liquid uranium (.200 kg, .9 moles) as a solvent. The liquid uranium was contained in a BeO crucible. The isothermal block was constructed from boron nitride and has a heat capacity of 16500 joules/C (4000 cal/C). The heat effect is measured by a thermocouple containing 120 thermocouple junctions of W vs. W-25Re stranded thermocouple wire. Calibration of the instrument indicates that the energy equivalent (heat capacity) ranged from 0.8100 joules/μV (.1950 cal/μV) to 0.6950 joules/μV (0.160 cal/μV). Calibration was based on the heat content, between room temperature and the calorimeter temperature, of weighed samples of pure uranium. The cooling constant showed a marked variation. Values of the cooling constant ranged from .280 to .428 min^{-1} with an arithmetic average of .360 min^{-1}. The partial heat of solution of vanadium, chromium, iron and nickel in uranium at 1150°C was determined. The values determined were $\overline{\Delta H}_V = -9020$ joules/mole (–2150 cal/mole), $\overline{\Delta H}_{Cr} = 57320$ joules/mole (11310 cal/mole), $\overline{\Delta H}_{Fe} = -11630$ joules/mole (–2780 cal/mole) and $\overline{\Delta H}_{Ni} = -26320$ joules/mole (–6290 cal/mole). (Diss. Abstr. Int., B)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstracts 50, 51, 244, and 2010.

410 (MLM–1957) STABLE ISOTOPE SALES: MOUND LABORATORY CUSTOMER AND SHIPMENT SUMMARIES, FY-1972. Stringham, W. S. (comp.) (Mound Lab., Miamisburg, Ohio). 21 Sep 1972. Contract AT-33-1-GEN-53. 24p. Dep. NTIS.

A listing is given of Mound Laboratory's sales of stable isotopes of noble gases and carbon for Fiscal Year 1972. Purchasers are listed alphabetically and are divided into domestic and foreign groups. A cross-reference index by location is included for domestic customers. Cross-referenced listings, by isotope purchased, are included for all customers. (auth)

411 PRODUCTION OF HEAVY WATER. Thayer, Victor R. U. S. Patent 3,685,966. 22 Aug 1972. Filed 4 Aug 1969.

Heavy water is concentrated by dual temperature exchange between hydrogen sulfide and water. The concentration is accomplished in a multi-stage system, utilizing process parameters requiring a higher temperature hot zone, a reduced recovery of the product from the feed water relative to the recovery theoretically possible, and limiting the increase in concentration per stage to a factor of less than 4. These operating parameters permit a substantial reduction in capital cost of the system. (Official Gazette)

412 DEUTERIUM SULFIDE SEPARATION AND ITS CONVERSION TO DEUTERIUM OXIDE. Glew, David N.; Clarke, Ewart C. (to Dow Chemical Co.). U. S. Patent 3,690,829. 12 Sep 1972. Filed 22 May 1970.

A process for concentrating deuterium values comprising distilling a liquid mixture of hydrogen sulfide and deuterium sulfides at a temperature of from about minus 45 to about 100°C is described. The gaseous distillate is enriched with respect to the deuterium sulfides. Ultimately the enriched distillate can be processed to convert the deuterium sulfides to deuterium oxides suitable for use as moderators in nuclear reactors. (Official Gazette)

413 URANIUM ENRICHMENT AND THE ULTRACENTRIFUGE. Bogaardt, M.; van de Wijngaert, B. H. Atoomenergie Haar Toepass.; 14: 208-15(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

In this review of gas centrifuge enrichment the following points are discussed: enrichment capacity required in the world and more particularly in Western Europe; enrichment methods now available or in development; the development of the gas centrifuge method in the Netherlands and the tripartite corporation in this field. (auth) (Netherlands)

414 COST ANALYSIS OF THE COMMERCIALIZED URANIUM ENRICHMENT PLANT BY GASEOUS DIFFUSION PROCESS OF U. S. A. Fujii, T.; Yoshida, K. (Kansai Electric Power Co. Inc., Osaka). Genshiryoku Kogyo; 18: No. 3, 33-7(Mar 1972). (In Japanese).

It is considered that jointly operated international uranium enrichment plants will be required by 1980. The gaseous diffusion process appears most practicable. Participating countries in this plan are not certain at present, but it is assumed that the scale of the first plant would be 8750 t-SWU. Cost of construction is estimated to be about 1050 million dollars. The plant consumes electric power of 875,000 MWD/year if PUI is assumed to be 10 kg-SWU/MWD. Construction of electric power plants is required, and the cost is estimated to be 480 million dollars if thermal power plants are constructed in Australia, and 500 million dollars if hydroelectric plants are constructed in Canada. Cost of the electric power is calculated on simple assumption to be 4.6 mills/KWh in the former case, and 2.5 mills/KWh in the latter case. On the whole, the fixed cost is calculated to be 137 million dollars/yr, the cost of electric power 126 million dollars/yr, and the cost of operation 15 million dollars/yr, the cost of production to be 31.7 dollars/kg-SWU. The Japanese proportion would need to be 38% of the capacity of the enrichment plant. (Japan)

Isotopic Power Sources

Refer also to abstracts 229 and 230.

415 (ALO-2832-45) EVALUATION OF A MOLYBDENUM FOIL-ZIRCONIA CLOTH INSULATION SYSTEM AFTER 10,000 HOURS AT A SOURCE TEMPERATURE OF ~1100°C (2012°F). Caffarelli, D. J.; Zawierucha, R. (Union Carbide Corp., Tonawanda, N. Y. Linde Div.). Sep 1972. Contract AT (29-2)-2832. 64p. Dep. NTIS.

Results of the molybdenum foil-zirconia cloth insulation system stability tests are reported. The test and post-test analyses were performed from November 1970 to August 1972. The objectives of this program are to evaluate and demonstrate long-term thermal performance stability of multi-layer insulations at source temperatures up to 1100°C for use in radioisotope power systems. The test system was maintained at stability test conditions for 10,000 hours. Upon completion of this test duration the system was disassembled for post test analysis. The results of the ensuing evaluation are documented. (auth)

416 (ARCO–3057-10) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Phase II. Quarterly Progress Report, May 1, 1972–July 31, 1972. (ARCO Nuclear Co., Leechburg, Pa.). 1972. Contract AT(11-1)-3057. 96p. Dep. NTIS.

During the report period research and development on the improved Radioisotope Powered Cardiac Pacemaker system (NU-5) continued. The NU-5 consists of the addition of 50% more insulation tape and additional restraints around the outer diameter of the thermopile to achieve a much tighter wrapping configuration. Various tests being performed tend to confirm that the NU-5 system is far superior to the previous NU-4 system and should result in acceptable performance. (T.F.D.)

417 (CEA-CONF-2042) HEAT TRANSFER FROM A RADIOISOTOPE GENERATOR, USING ORGANIC FLUIDS. Cavoret, J. C.; Lavigne, P.; Teytu, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 6p. (In French). (CONF-720648–12). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

An organic fluid is used to transfer heat from the cobalt-60 source to the converter boiler of a radioisotope source generator with an output of about 100W. The turbine converter operates with an organic working fluid. The generator, its thermal characteristics, and the safety systems associated are described. (France)

Radiation Sources

Refer also to abstract 265.

418 RADIOISOTOPES AND THEIR INDUSTRIAL APPLICATIONS. Vassaux, J. Maintenance; No. 23, 11-18(Jun 1972). (In French).

The characteristics and the behavior of the different radioisotopes used in industry are summarized. Their various industrial applications are enumerated. Safety aspects are included in these applications. The permissible doses for personnel using these isotopes are discussed. The apparatus used for measuring and detecting ionizing radiations are described. (France)

419 GERMAN IMPORT AND EXPORT OF RADIONUCLIDES IN 1971. Atomwirt., Atomtech.; 17: No. 9-10, 500-1(1972). (In German).

The import and export of radionuclides for the year 1971 is compiled in five tables. The figures are broken down with respect to country and specific nuclide. During the year, the import increased by 16%. With the exception of tritium, the import of all other nuclides increased. With respect to imported curies, the sequence of countries was as follows: France, Great Britain, Belgium, Switzerland, Holland, and USA. In comparison to the previous year, the export increased especially for iridium-192 sources. The inter-German trade of radionuclides also increased during the reported time period. (H.B.G.)

Design and Fabrication

Refer also to abstracts 341 and 890.

Industrial Uses

Refer also to abstracts 315, 430, 435, 454, 470, and 475.

420 (AAEC/M–88) GAMMA TECHNOLOGY RESEARCH IRRADIATOR (GATRI): DESCRIPTION AND OPERATING PROCEDURES. Bolton, J. H.; Clouston, J. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 29p. Dep. NTIS (U. S. Sales Only).

The manual details administrative and technical operations associated with the use of GATRI with a description of controls, alarms and warnings, operating procedures, routine operations, source loading into the cell, maintenance, waste disposal, unattended operations and safety philosophy. (Australia)

421 (ORNL-4819) REVIEW OF ALPHA RADIATION SOURCE PREPARATION METHODS AND APPLICATIONS. Greene, R. E.; Pressly, R. S.; Case, F. N. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 52p. Dep. NTIS.

A review of the literature on the preparation methods, evaluation, and applications of alpha sources of Po, Th, U, Np, Pu, Am, and Cm isotopes is presented. The characteristics and properties of alpha particles and the selection of an alpha emitter for a particular application are also described briefly. The review does not include information on radium sources or on the use of alpha emitters as sources of heat and energy. About 200 references are cited. (auth)

422 SURVEY OF METHODS USED TO DETECT LEAKS IN UNDERGROUND INSTALLATIONS. Dixon, R. D.; DiGiallonardo, A. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Water Sewage Works; 4p.(Jun 1972). (RFP-1796).

Methods for detecting leaks in underground systems for distributing materials such as oil, gas, raw water, potable water, sewage, and process wastes are discussed. Leaks in underground pipe lines can be detected using radioactive tracers, non-radioactive tracers such as dyes and special gases, and sonic and ultrasonic detectors. Leaks in underground storage tanks containing liquids are commonly detected by the use of liquid level indicators, while leaks in gas storage tanks can be detected by pressure monitoring. Finally, the use of ultrasonic thickness measurements for monitoring the physical condition of pipes and thereby preventing potential leaks in underground piping systems is discussed. (L.C.L.)

423 EFFECT OF DIET SUPPLEMENTS AND GAMMA IRRADIATION ON DISSIMILATION OF LOW-QUALITY ROUGHAGES BY RUMINANTS. 3. EFFECTS OF FEEDING GAMMA-IRRADIATED BASE DIETS OF WHEATEN STRAW AND RICE STRAW TO SHEEP. McManus, W. R. (New South Wales Univ., Kensington, Australia); Manta, L.; McFarlane, J. D.; Gray, A. C. J. Agr. Sci.; 79: No. 1, 55-66(Aug 1972).

Results of two experiments in which gamma-irradiated low-quality cereal straws were fed ad libitum to sheep, with and without supplements, are reported. In the first experiment adult Merino wethers were fed chopped wheaten straw irradiated at 50 Mrad or non-irradiated wheat straw, each roughage was fed with and without a supplement of urea, minerals, and vitamins. In the second experiment 16 adult Merino wethers were fed diets of chopped rice straw or chopped rice straw irradiated at 25, 50 or 75 Mrad; each of these roughages was fed with and without a supplement of casein, minerals, and vitamins. Gamma-irradiated diets were invariably associated with reduced mean retention times of undigested feed particles in the digestive tract, and a depressed digestibility of dietary dry matter. (auth)

424 ESTIMATION OF THE MINIMUM LENGTH OF THE TEST SECTION IN PULSE VELOCITY METHOD MEASUREMENTS. Korbel, Kazimierz (Inst. of Nuclear Physics, Krakow). Nukleonika; 17: No. 1-2, 115-21(1972).

Aspects of the proper estimation of the test-section-length in radiotracer measurements of the fluid flow in a pipe-line are examined. This length in a case of the continuous injection of the tracer is to be determined according to the requirement of the good mixing, and is called generally the mixing distance. It is proposed for the pulse-velocity-method to estimate the minimum test-section-length upon the condition of the admissible error of the mean transit-time determination using the peak-timing techniques. (auth)

425 DETERMINATION OF THE WEAR OF HEAVY CURRENT CONTACTS WITH RADIOISOTOPES. Farkas, T.; Hirling, J. (MTA Izotop Intezete, Budapest). Izotoptechnika; 15: No. 5, 267-75(May 1972). (In Hungarian).

Processes of contact wear are discussed, and a method for measuring wear of activated silver and silver-cadmium contacts using the isotope dilution technique is described. (auth)

426 RADIATION STERILIZATION WITH THE VAN-DE-GRAAFF ACCELERATOR. Jahn, W.; Schinkmann, M. (Leybold-Heraeus, Cologne). Atomwirt., Atomtech.; 17: No. 9-10, 527-9(1972). (In German).

Radiation sterilization of medical disposable articles is one of the few areas in which high-energy electron and γ radiation presently find industrial application. With increasing use of disposable articles, the method attracts growing interest. The sterilization process obeys statistical laws. Because of this fact, certain special aspects of radiation sterilization must be considered. An electron beam sterilization installation is presented as an example and is discussed from technical and economical standpoints. (tr-auth)

LIFE SCIENCES

Refer also to abstract 143.

427 (ORNL–4817) BIOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1972. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 183p. Dep. NTIS.

Separate abstracts were prepared for five sections in this report. Brief summaries of 325 projects in biochemistry, biophysics and cell physiology, genetics and developmental biology, mammalian genetics, pathology and immunology, and carcinogenesis are presented. (E.R.B.)

For abstracts of individual sections see: 429, 449, and 519–521.

428 MODIFYING FACTORS AND DOSE EQUIVALENT IN RADIATION PROTECTION. Wheatley, B. M.; Burlin, T. E. (Central Electricity Generating Board, Berkeley, Eng.). Brit. J. Radiol.; 45: No. 538, 785-6(Oct 1972).

The relationships between quality factor (QF), dose-equivalents, and maximum permissible dose (MPD) are discussed briefly in relation to the recommendations of the ICRP, ICRU, and the British Committee on Radiation Units and Measurements. Improvements in the definitions of modifying factors (particularly QF) are pointed out, and the need stressed for the resolution of ambiguities. The usefulness of the concept of dose equivalent is questioned. It is pointed out that the rem has been used for 18 yr and has been useful for emphasizing the importance of Linear energy transfer (L) and in suggesting that other modifying factors, especially organ dependent factors, could influence permissible doses, but that these objectives could be achieved with established physical quantities such as dose, L_∞, and fluence. (UK)

Radiation Effects on Biochemicals

429 (ORNL–4817, pp 29-63) BIOPHYSICS AND CELL PHYSIOLOGY. Oct 1972.

In Biology Division annual progress report for period ending June 30, 1972.

Brief summaries of 74 projects in biophysics and cell physiology are presented. Specific areas of research include: cell physiology; chromosome chemistry; growth and regeneration; molecular biology; radiation biophysics; x-ray diffraction; excited-state biophysics; microbial photosynthesis; photosynthesis; plant physiology; and cellular radiobiology. (E.R.B.)

430 INFLUENCE OF GAMMA RADIATION ON THE LIPIDS OF PEANUTS AND WALNUTS. PART I. QUALITATIVE AND QUANTITATIVE INVESTIGATIONS OF NEUTRAL LIPIDS AND FREE FATTY ACIDS. Bancher, E.; Washuettl, J.; Goller, H. J. (Technische Hochschule, Vienna). Seifen-Oele-Fette-Wachse; 98: No. 12, 370-2(1972). (In German).

The structure of the neutral lipid of fresh peanuts and walnuts has been investigated by thin-layer chromatography, followed by the quantitative determination of irradiation-induced changes. The results show a decrease in triglycerides, as well as an at least partially corresponding increase in di- and monoglycerides and in free fatty acids. After irradiation with higher doses, large amounts of peroxide-containing compounds were found, and also considerable amount of polymers, especially in walnut oil. On the whole, the walnut lipids appeared to be more strongly affected by high-energy radiation than those of the peanuts. Due to the polymerizations that were found, even oils irradiated at very low doses cannot be approved for consumption. (GF)

431 INFLUENCE OF ULTRAFAST REPAIR PROCESSES (INDEPENDENT OF DNA POLYMERASE I) ON THE YIELD OF DNA SINGLE-STRAND BREAKS IN ESCHERICHIA COLI K-12 X-IRRADIATED IN THE PRESENCE OR ABSENCE OF OXYGEN. Town, Christopher D.; Smith, Kendric C.; Kaplan, Henry S. (Stanford Univ., Calif.). Radiat. Res.; 52: No. 1, 99-114(Oct 1972).

The rate of production of DNA single-strand breaks has been studied in several polA1 derivatives of Escherichia coli K-12 x-irradiated in the presence or absence of oxygen. For log phase cells irradiated in phosphate-buffered saline, pH 7.3, the rate of production of breaks per single-strand genome per krad was 2.13 in the presence of air, and 0.66 in its absence [an oxygen–nitrogen breaks ratio (ONBR) of 3.2]. To determine if this oxygen effect was due to a difference in the absolute yield of breaks or to a differential ability for repair, the yield of single-strand breaks was studied in cells which had been inactivated either by heat treatment (52°C) or cold shock (0°C). In both cases there was a large increase in the yield of radiation-induced anoxic breaks (2.8-fold) and a small increase (1.25-fold) in aerobic breaks. Attempts were also made to inhibit repair using chemicals. Sodium cyanide (1 mM) used at 0°C had no effect on the anoxic yield of breaks. However, in the presence of quinacrine (0.2 mM) the level of anoxic breaks increased above that seen in untreated pol$^-$ cells, while the aerobic level was the same. N-ethylmaleimide, NEM (0.5 mM), had a similar effect, but another SH-enzyme inhibitor, iodoacetic acid (1 mM), had no effect. Hydroxyurea (10 mM) had an effect qualitatively similar to NEM. These results suggest that E. coli possess an ultrafast repair system, which operates mainly on anoxic breaks and can be inhibited by physical or chemical pretreatment of the cells. This inhibition permits the demonstration that the initial yield of x-ray-induced DNA single-strand breaks in vivo is largely independent of the presence of oxygen, but that the yield of breaks in anoxic cells is very rapidly modified by repair. (auth)

432 INTERACTION OF LOW ENERGY PROTONS WITH RIBONUCLEASE. Dennis, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Med. Biol.; 17: No. 2, 304-6(Mar 1972).

The following parameters relevant to the interaction of protons from 0.100 keV to 100 keV with ribonuclease are tabulated from the available literature: stopping powers, slowing down range, mean projected range, mean deviation of projected range, inactivation range, energy dissipated in nuclear collisions. (UK)

433 REPAIR ENZYME SUGGESTED BY MAMMALIAN ENDONUCLEASE ACTIVITY SPECIFIC FOR ULTRAVIOLET-IRRADIATED DNA. Brent, T. P. (McGill Univ., Montreal). Nature (London) New Biol.; 239: No. 93, 172-3(11 Oct 1972).

Alkaline sucrose gradient sedimentation techniques were used to demonstrate the DNA strand breaking effect of ultraviolet irradiation (0 to 100 ergs/mm^2 $\times$ 10^{-3} fd up to 6 min), and endonuclease activity in HeLa cells previously irradiated with 17000 ergs/mm^2. Endonuclease activity was assayed by following the conversion of superhelical circular PM2 bacteriophage DNA to the nickel circular form. The results demonstrated the involvement of endonuclease activity in the excision-patch repair process in uv-irradiated HeLa cells. (UK)

434 LONG-TERM EFFECTS OF X RADIATION ON NUCLEIC ACID AND PROTEIN METABOLISM IN RAT SKIN. van der Schueren, E.; Jullet, R.; Doms, D.; de Loecker, W. (Univ., Louvain, Belgium). Int. J. Radiat. Biol.; 22: No. 4, 361-6(Oct 1972).

The in vitro incorporation of 3H-thymidine into the nucleic acids and ^{14}C-glycine-2 into the proteins of rat skin was examined simultaneously through three consecutive hair-cycles, in an attempt to approach the mechanism of long-term radiation damage. An initial single x irradiation (1500 or 3000 R), carried out on the skin of the back before the start of the experiment, resulted in a prolonged inhibition of thymidine incorporation, while a stimulation of glycine incorporation into the proteins was observed. These results, supporting earlier indications of an initial effect by x irradiation, provided new evidence of an independent cytoplasmic effect specifically involving protein synthesis. (auth)

435 STUDIES ON THE BREADMAKING PROPERTIES OF GAMMA-IRRADIATED WHEATS. Tanaka, Y.; Koyanagi, Y.; Toyoshima, H.; Umeda, K.; Sato, T. (Food Research Inst., Tokyo). Nippon Shokuhin Kogyo Gakkaishi; 18: No. 8, 400-5(Aug 1971). (In Japanese).

Gamma ray irradiation with the dosages of 20, 50 and 100 Krads was applied to an imported hard wheat (Manitoba) and a domestic wheat (Norin-27), and its effects on breadmaking properties were investigated. After preparing 60% extraction flours with a Bühler test mill, maltose value (M.V.), sedimentation value (S.V.), characteristics of dough, and breadmaking properties of the flours were evaluated. The maximum viscosity of Amylogram, M.V. and S.V. decreased with dose. However, little change was observed on Farinogram or Extensogram. As the results of baking trials, the effects of irradiation were recognized regarding loaf volume, flavor, and total score of bread. Loaf volume of the bread made immediately after the irradiation was not influenced by the treatment. As for the breads prepared from the flours milled after three month storage of the irradiated wheats, however, the increases in loaf volume were recognized in all the irradiated samples. Organoleptic evaluation of the bread was performed by experienced taste panels. In the test carried out immediately after the treatment, off-flavor was found distinctly in all the breads made from treated wheats. However, the off-

flavor was diminished when the test was performed on the breads made from the wheats stored for three months. On the whole, more intense effects of irradiation were observed in Manitoba than Norin-27. (Japan)

436 ACTION OF PROTEOLYTIC ENZYMES ON X-IRRADIATED ACID SOLUBLE RAT SKIN COLLAGEN SOLUTION. Mazanowska, Anna; Dancewicz, Antoni M.; Rzepniewska, Dobroslawa (Inst. of Nuclear Research, Warsaw). Nukleonika; 17: No. 1-2, 131-44(1972).

Rat skin, acid soluble collagen was irradiated in anaerobic solutions or in the presence of air with the 1 to 40 kilorad doses of x-rays and then treated with pepsin, trypsin, pronase or collagenase. Radiation induced changes in collagen susceptibility to the action of these enzymes were estimated from viscosity measurements, determinations of the content of amino groups which react with fluorodinitrobenzene and from the pattern of thermal aggregation of collagen solutions. It was found that proteases (pepsin excepted) abolish almost completely the increase in viscosity of collagen solution irradiated in vacuum. On the other hand irradiation in air deepens somewhat the viscosity decrease induced by proteases. The action of proteases on collagen irradiated in vacuum liberated fewer, or at least the same number of free amino groups as did the proteases action on native, nonirradiated collagen. The presence of air during irradiation caused an increase in the number of amino groups liberated by the action of proteolytic enzymes on collagen. Both the separate and the joined action of radiation and proteolytic enzymes on collagen caused a slowing down and diminishing extent of thermal aggregation of its solutions. This phenomenon was stronger when both agents were applied jointly. Results obtained lead to the conclusion that collagen susceptibility to the action of proteolytic enzymes is slightly diminished when irradiation was performed in vacuum and increased when irradiation was performed in air. (auth)

437 SEROLOGIC ESTIMATION OF THYMINE DIMERS IN THE DEOXYRIBONUCLEIC ACID OF BACTERIAL AND MAMMALIAN CELLS FOLLOWING IRRADIATION WITH ULTRAVIOLET LIGHT AND POSTIRRADIATION REPAIR. Seaman, E.; Van Vunakis, H.; Levine, L. (Brandeis Univ., Waltham, Mass.). J. Biol. Chem.; 247: No. 18, 5709-15(25 Sep 1972).

The repair of thymine dimers induced by irradiation with ultraviolet light was detected in the DNA of human fibroblast cells, HeLa, but not in the DNA of rat glial or rat pituitary cells. Thymine dimers were detected in the DNA of bacterial and mammalian cells after irradiation with levels of light which are biologically significant, as little as 50 ergs per mm^2. The detection of thymine dimers involves the use of specific antibodies to these photoproducts in a radioimmunoassay that can be performed directly on the DNA extracted from the cells. The validity of the assay in the study of repair processes in mammalian cells was first established in a well defined bacterial system. The appearance and excision of thymine dimers in DNA of Bacillus subtilis 101 (an ultraviolet-resistant strain) and B. subtilis 124 (an ultraviolet-sensitive strain which lacks the ability to excise the photoproducts after ultraviolet irradiation) were estimated serologically and were correlated with the transforming activities of the DNA extracted from the cells after irradiation and after a recovery period. (auth)

Radiation Effects on Cells

Refer also to abstract 433.

438 (COO-3335-13) MOLECULAR EVENTS BASIC TO CELLULAR RADIATION RESPONSE. Progress Report, January 1, 1972-December 31, 1972. Kolodny, G. M. (Massachusetts General Hospital, Boston. Radiology Research Lab.). [nd]. Contract AT(11-1)-3335. 37p. Dep. NTIS.

During the past year research has been directed in several interrelated areas significant to the understanding of the normal controls on cell division and the effects of radiation on cell division. Because of the possibility of cell to cell transfer of molecules being important in the maintenance of contact inhibition of cell division the transfer of macromolecules between cells was studied. In particular this past year it was found that cells not only exchange RNA but they also exchange proteins including nuclear proteins. Histones were found to be transferred to a greater extent than other nuclear proteins. Because of this preferential transfer of histones and other evidence of histones as genetic repressors the effects of exogenous histones on cell cultures were investigated and it was found that histones cause marked changes in cell morphology and increased cell number at confluence. Differences amongst the histone subfractions in their effects were also found. Investigations of the role of RNA as repressors of genetic functions such as cessation of division in contact inhibited cells showed that RNA is not present in sufficient quantity in association with DNA of fully repressed chicken erythrocytes to act in genetic repression of these cells. Metabolic influences on cell division in normal and transformed cells were investigated. It was found that untransformed cells produced more ammonia than their transformed counterparts. Untransformed cells were more adversely affected by added ammonia than nontransformed cells. These changes caused by added ammonia were independent of pH changes. (auth)

439 (UCSF-10-P-2-171) REPAIR PROCESSES FOR PHOTOCHEMICAL DAMAGE IN MAMMALIAN CELLS. Cleaver, J. E. (California Univ., San Francisco. Lab. of Radiobiology). 1972. Contract AT(11-1)-Gen-10. 137p. Dep. NTIS.

A review is presented of repair processes for photochemical damage in cultured mammalian cells. Various aspects of repair are illustrated using cultured cells of the human skin disease, xeroderma pigmentosum. Studies on DNA and other cellular components as critical target structures for uv-induced damage and repair pathways for DNA and proteins are discussed. The process of excision repair is reviewed with regard to excision of uv photoproducts, strand breakage during excision, incorporation of new bases, semiconservative replication of repaired DNA, selectivity of repair replication for thymidine over BUdR, patch size from excision repair, repair replication in the absence of protein synthesis, the influence of inhibitory drugs, mutant selection schemes, and enzymatic defects in xeroderma pigmentosum cells. The S-phase recovery or post-replication repair and photoreactivation are also reviewed. (H.L.W.)

440 EFFECTS OF X-IRRADIATION ON HISTONE ACETYLATION AND METHYLATION IN CULTURED MAMMALIAN CELLS. Shepherd, G. R.; Walters, R. A.; Hardin, J. M.; Noland, B. J. (Los Alamos Scientific Lab., N. Mex.). Arch. Biochem. Biophys.; 149: No. 1, 175-82(Mar 1972). (LA-DC-13143).

Random populations of mammalian cells in suspension culture with generation times ranging from 16 to 17 hr were subjected to 1600 rads of x irradiation. Irradiated cells displayed a postirradiation division delay period of approximately 16 hr, during which period protein accumulation continued. DNA and histone biosynthesis ceased between 10 and 12 hr postirradiation. Approximately 15% of the irradiated population completed their first postirradiation division 16 hr after irradiation, and very few were able to complete a second division. The DNA, protein, and histone contents of the cell population rose during the division delay period, approximating levels attained by normal cells in the G_2 portion of their life cycle. Accumulation of labeled acetate in histone fractions F1, F2b, and F3 of irradiated cells paralleled control values, while accumulation of incorporated acetate into histone fraction F2a of irradiated cells was depressed below control values between 16 and 24 hr after irradiation. Accumulation of labeled methyl groups as methyl-lysine derivatives in histone fractions F2a, F2b, and F3 of irradiated cells was depressed below control values 24 hr postirradiation. No methylation of the lysine residues of histone fraction F1 was observed in either control or irradiated cultures during this period. Histone acetyltransferase and methyltransferase activity levels increased during the division delay period to follow the accumulation of cellular protein in irradiated cells. However, enzyme activity increased more rapidly than total protein, reached G_2 levels at 16 hr and decreased with resumption of cell division. These observations provide confirmatory evidence that mammalian cells irradiated under these conditions are arrested within the cell cycle in G_2 or a G_2-like state. (auth)

441 SURVIVAL CURVES AND AGE RESPONSE FUNCTIONS FOR CHINESE HAMSTER CELLS EXPOSED TO X-RAYS OR HIGH LET ALPHA-PARTICLES. Hall, E. J.; Gross, W.; Dvorak, R. F.; Kellerer, A. M.; Rossi, H. H. (Columbia Univ., New York). Contract AT(30-1)-2740. Radiat. Res.; 52: No. 1, 88-98(Oct 1972).

Chinese hamster cells were synchronized with hydroxyurea and exposed to either 800 rads of x rays, or 250 rads of alpha particles at different points of the cell cycle. The pattern of response to x rays is similar to that previously reported, namely, an increase in radioresistance to a maximum in late S, followed by a sensitive period in the late G_2 and M phases of the cycle. The pattern of response to alpha particles is qualitatively very similar; the variation between most sensitive and most resistant phases of the cell cycle is less than in the case of x rays, but is still appreciable. The alpha particles have a LET of approximately 90 keV/μm, and it was thought possible that the age response function would be flat for such densely ionizing radiation; however, this was not found to be the case. (auth)

442 SIZE OF REPAIR PATCHES IN THE DNA OF ULTRAVIOLET-IRRADIATED HeLa CELLS. Edenberg, H.; Hanawalt, P. (Stanford Univ., Calif.). Biochim. Biophys. Acta; 272: No. 3, 361-72(Jul 1972).

Repair replication in uv-irradiated HeLa-S_3 cells was examined to determine the size distribution of the repair patches in the parental DNA. DNA containing patches of repair replication labeled with [^{3}H]BrdUrd was isolated by CsCl isopycnic sedimentation. The repaired DNA was rebanded in alkaline CsCl after sonication (to reduce molecular weight to $0.2 \cdot 10^6$) or without sonication. The peak of repair label coincided with that of the parental density DNA in the larger fragments, and even in the very small fragments the two peaks nearly coincided. No large repair patches were evident, in contrast to the result in Escherichia coli in which most of the repair label appears in extremely large patches. From the shift observed in the smallest fragments (about 5% of the distance between fully light parental DNA and BrdUrd-containing heavy DNA) the average size of repair patches in HeLa DNA was calculated to be about 30 nucleotides. (auth)

443 STUDY ON THE INFLUENCE OF RADIATION UPON THE LYMPHOCYTE. CHANGES IN CHROMOSOME AND BLASTIC TRANSFORMATION OF THE LYMOHOCYTES INDUCED BY RADIATION. Yamada, Takaki (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi; 28: No. 3, 517-33(May 1970). (In Japanese).

Abnormalities were found in chromosomes and content of phytohemagglutinin (PHA) of lymphocytes after irradiation by ^{60}Co gamma rays. Aneuploid cells and chromosome aberrations, both stable and unstable, increased with increasing doses in in vitro experiments. Chromosome aberration with polyploidy was observed in patients under radiotherapy and normal persons as well. The appearance rate of PHA cells, large sized cells in particular and middle sized cells, decreased following increasing doses of irradiation. PHA cells decreased suddenly after irradiation with small doses (50 R, 100 R), and then presented a slow decreasing curve with an increase of doses. Twenty-four percent of PHA cells were still observed even after the application of 3000 R. Such abnormal PHA cells as polynuclear cells, cells with vacuoles in their protoplasm, and cells with inclusion bodies were observed by application of 1000 and 2000 R. No significant changes were observed in the appearance rate of PHA cells after irradiation with 1000 R in the lymphocyte culture. It was found that non-PHA-added lymphocytes were more sensitive to irradiation than PHA-added lymphocytes in the culture. It is suggested that PHA protects the cell walls against irradiation. Various disorders due to irradiation always take place among the radiation workers and the patients under radiation treatment. It is possible that the chromosome aberrations of medullary cells and lymphocytes could be the cause of the occurrence of leukemia or cancer. It is suggested that the occurrence of chromosome aberrations in lymphocytes after irradiation might cause deficiency of immunological mechanism in lymphocyte function. (Japan)

444 EFFECT OF IRRADIATION ON TUMOR MICROVASCULAR PERMEABILITY TO MACROMOLECULES. Potchen, E. J.; Kinzie, J.; Curtis, C.; Siegel, B. A.; Studer, R. K. (Washington Univ., St. Louis). Contract AT(11-1)-1653. Cancer; 30: No. 3, 639-42(Sep 1972).

In C3H mouse Gardner lymphosarcoma we have demonstrated an increase in the extravascular albumin space 48 hrs after delivering 3,000 rads of irradiation. This observation has implications for organ radiobiology in that the microvascular effect could alter radiation response in tumors. This effect may be time dependent and thus may be an extremely important consideration in dose fractionation which is not necessarily dependent on tumor cell cytokinetics. (auth)

445 EFFECT (IN VITRO) OF NATURAL IONIZING RADIATIONS ON HUMAN CANCER CELL STRAINS. Croute, F.; Tixador, R.; Planel, H.; Soleilhavoup, J. P. (Univ., Toulouse). Compt. Rend. Soc. Biol.; 165: No. 11, 2189-93(1971). (In French).

Strains of cancerous human cells were cultivated in order to study the effect of natural ionizing radiations on such cells; radioprotection facilities were employed. It was observed that extensive radioprotection leads to a slowdown in the growth rate of the cells. This slowdown is not constant and is inferior to that observed with certain single celled organisms such as Paramecium. (France)

446 CELL CYCLE DEPENDENCE ON THE LETHAL RADIATION RESPONSE IN MAMMALIAN CELLS. Sinclair, W. K. (Argonne National Lab., Ill.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 264-85(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Studies on cyclic variations in the lethal radiation response of hamster cells and HeLa cells to x rays are reviewed. Some topics discussed are: response of cell lines with short and long G_1 phases; relation of DNA synthesis (S period) to survival of x-irradiated hamster cells; modification of radiation response by LET, dose fractionation, oxygen, and other factors; and effects of hydroxyurea, MEA, and NEM on survival of x-irradiated hamster cells. (H.L.W.)

447 CHROMOSOME ABERRATIONS INDUCED IN VITRO BY RADIATIONS OF LOW LET IN BLOOD CELLS OF MAN. Feremans, Willy (Centre P. Cogniaux, Brussels). J. Belge Radiol.; 55: No. 2, 207-21(1972). (In French).

The number and types of chromosome aberrations induced in human lymphocytes in cultures following exposure to 200 keV x radiation, ^{60}Co γ radiation, and 20 and 35 MeV electrons were compared. The cells were irradiated at 48 and 72 hours following culture under identical conditions of oxygen and temperature. The percent of normal cells and the percent with chromosome aberrations were determined 24 hours following irradiation. (C.H.)

Radiation Effects on Microorganisms

Refer also to abstracts 429 and 513.

448 (COO-3482-6) DOSE MODIFICATION IN E. COLI BY A CONSTITUTIVE RADIOPROTECTIVE AGENT ISOLATED FROM M. RADIODURANS. Goldstein, L. S. (State Univ. of New York, Buffalo). Sep 1972. Contract AT(11-1)-3482. 99p. Dep. NTIS.

Thesis.

A constitutive low molecular weight radioprotective agent has been isolated from a colorless mutant of Micrococcus radiodurans. Organic separation with butanol and isoamyl alcohol demonstrates that it is hydrophilic in nature. Chromatographic resolution using Sephadex G-25 shows it to be comprised of two separate moities, both having a molecular weight between 1,000 and 5,000 daltons. The two appear to be either tautomeric forms or dimers of the same molecule. The high distribution coefficient indicates the probable presence of a heterocyclic ring subgroup. The agent is resistant to digestion by DNase, RNase, pronase and lipase. Radioprotection of Escherichia coli B/r in the presence of extract is optimal when the sample is both aerobic and quiescent. Under these conditions the dose modification factor is 3.2. Preincubation in extract before irradiation in phosphate buffer results in no added protection. Incubation in extract after irradiation in phosphate buffer results in a dose modification of 1.3. Microscopic examination reveals that the protective agent causes the cells to aggregate and also causes nuclear condensation, loss of the periplasmic space and clustering of ribosomes in individual cells. The effect of the radioprotective extract was also investigated in three mutant strains of E. coli B/r differing from one another at a given locus concerned with the repair of radiation induced damage. The expression of two of the resistance genes, designated hcr and exr, was seen to be determined by the state of aerobiosis during irradiation; exr was expressed under aerobic conditions while hcr was expressed only during anaerobiosis. The gene which controls the formation of septae between daughter cells after x-irradiation, designated fil, was expressed both in the presence and absence of oxygen. Extract increased the effect of both exr and hcr by approximately 12% while augmenting fil by 140%. Alkaline sucrose density gradient centrifugation revealed that the radioprotective extract does not prevent the formation of single strand breaks in DNA, nor does it augment their repair. Extract apparently induces the formation of such lesions in fil$^+$ cells without exogenous ionizing radiation. An hypothesis is advanced to explain radioprotection by extract based on differential sites and/or types of damage incurred by the cell for aerobic and anaerobic conditions of irradiation. (auth)

449 (ORNL-4817, pp 64-109) GENETICS AND DEVELOPMENTAL BIOLOGY. Oct 1972.

In Biology Division annual progress report for period ending June 30, 1972.

Brief summaries of 84 projects in genetics and developmental biology are presented. Specific areas of research include: morphogenesis and cytochemistry; microbial genetics and radiation microbiology; mammalian cytogenetics; human genetic biochemical defects analysis; mammalian cytology and cell genetics; mammalian biochemical genetics; fungal genetics; Drosophila biochemical genetics; Drosophila chromosomal behavior; structure and function of multienzyme complexes; cell growth and differentiation; chromosome ultrastructure; vitellogenesis; molecular basis of recombination and repair of DNA; and hymenopteran genetics and genetic methods for insect control. (E.R.B.)

450 (SC-DC-721649) THERMAL ENHANCEMENT OF RADIOSTERILIZATION. Reynolds, M. C.; Brannen, J. P. (Sandia Labs., Albuquerque, N. Mex.). 1972. 18p. (CONF-721101-2; SM-166/48). Dep. NTIS.

From International symposium on radiation preservation of food; Bombay, India (13 Nov 1972).

There can be considerable merit in combining simultaneous low temperature thermal treatment with ionizing radiation for bacterial inactivation. Under certain conditions, synergistic inactivation has been observed. This study was made to determine what conditions produce this synergism and to characterize it mathematically. A general enhancement was observed through the experimental ranges of 25 to 125°C and 1000 to 660,000 rads per hour. The degree of enhancement, however, varied from a highly synergistic inactivation to an inactivation rate approximately equal to the nominal singular effects of heat and radiation. This variability was only in part due to the temperature dependency of radiation inactivation. Of equal importance was the effect of radiation dose rate and the interrelationship between dose rate and temperature. The degree of synergism was found to be a non-linear function of dose rate at any given temperature. That is, for a given temperature, there was a specific dose rate which maximized synergy. Consequently, optimal sterilization or inactivation to a desired level can be achieved in less time using correspondingly smaller amounts of heat and radiation. For example, a 10 log population reduction of Bacillus subtilis var. niger using gamma radiation at room temperature normally requires 1.5 to 2.5 million rads. Using dry heat alone at 95°C, the same population reduction requires 120 to 150 hours. By combining these treatments at the optimum dose rate, the same level of inactivation can be accomplished in 30 hours, with a total dose of 200,000 rads or about $1/10$ of the normal radiation dose. This behavior was observed in the inactivation response of bacterial spore-formers, bacteriophage, coliform, and naturally occurring mixed populations. The generality of this synergistic behavior in biosystems has permitted its characterization mathematically. This characterization leads to optimization of inactivation for many different conditions and develops a better understanding of biosystem response to specific changes in treatment. (auth)

451 CYCLE DEPENDENT VARIATION OF X-RAY EFFECTS ON SYNCHRONOUS MITOSIS AND THYMIDINE KINASE INDUCTION IN PHYSARUM POLYCEPHALUM. **Sachsenmaier, W. (Univ., Innsbruck); Bohnert, E.; Clausnizer, B.; Nygaard, O. F. FEBS (Fed. Eur. Biochem. Soc.) Lett.; 10: No. 3, 185-9(Oct 1970). (COO-78-234).**

The question of whether a radiation induced delay of mitosis is accompanied by a corresponding change of the time marker for thymidine kinase induction or whether these two events can be dissociated was studied. Further, the cycle dependent variation of the x-ray effects was studied in order to learn more about the possible action mechanism of ionizing radiation. The results indicate that the radiosensitivity of Physarum plasmodia changes drastically during the synchronous nuclear division cycle. The time markers of mitosis and of thymidine kinase induction are equally affected by x rays suggesting that the control mechanisms of these two events are indeed closely related or even identical. (auth)

452 INFLUENCE OF IONIZING RADIATION ON ANIMAL VIRUSES. PART I. GAMMA-RAY INACTIVATION OF AUJESZKY VIRUS. **Dilovski, M. (Veterinary Inst. of Infectious and Parasitic Diseases, Sofia). Zentralbl. Veterinaermed., Reihe B; 19: No. 2, 128-35(1972). (In German).**

The viruses were irradiated at 18 to 20°C in the medium using γ rays at 1773 R/min. The surviving fraction was determined by means of plaque-technique. The infectivity was assayed in mice and rabbits. The kinetics of the inactivation of Aujeszky virus by gamma ray irradiation depend on the viral titre, the radiation dose, and the irradiation temperature. Different cell species and media used for the cultivation of the virus have no effect on inactivation. A reversible change in the size of the plaques suggests an alteration of the phenotypic characters of the virus. The effect of gamma irradiation on the immunogenic properties of the virus is discussed in relation to vaccine production. (GF)

453 STUDY OF THE MUTAGENIC EFFECT OF ULTRAVIOLET RAYS ON WINE YEAST. **Semin, V. S.; Rusnak, A. F. (Moldavian Scientific-Research Inst. of Horticulture, Viticulture, and Viniculture, Kishinev). Tsitol. Genet.; 2: No. 6, 559-62 (1968). (In Russian).**

A comparative effect was studied of different doses of ultraviolet rays on vegetative diploid cells and sporulating culture of the Leningradskaya strain of yeast. The results reflecting the lethal and mutagenic (microcolonies) effects of irradiation testify to a multiple increase of radiosensitivity in the period of spore formation. As a fine mutagenic factor, ultra-violet rays must be used in selecting productive strains of yeast. It is expedient to irradiate sporulating cultures. (auth)

454 STUDIES ON MICROBIOLOGICAL SAFETY OF IRRADIATED FOODS. 2. INOCULATED PACK TESTS ON CLOSTRIDIUM BOTULINUM TYPE E IN SURIMI. **Ando, Yoshiaki; Sato, Hideo; Nakagawa, Tetsuo (Hokkaido Inst. of Publich Health, Sapporo). Hokkaidoritsu Eisei Kenkyushoho; No. 21, 176-9(Jun 1971). (In Japanese).**

In order to assess the public health hazard of Clostridium botulinum type E in radurized fish, inoculated pack tests were carried out, using "surimi" (frozen ground fish flesh). Triplicate samples were inoculated with 10^6 and 10^4 of spores of Iwanai strain per g of surimi, then irradiated at a dosage of 300 Krads, and stored at 5°C or 10°C along with inoculated unirradiated controls. The results are as follows: At 5°C storage, neither irradiated samples nor unirradiated controls showed toxin development up to one month. At 10°C storage, toxin was detected in irradiated samples within 11 to 17 days, while unirradiated controls remained nontoxic up to 20 days. (auth)

455 FORMATION OF GLUTAMIC ACID FROM DEFATTED SOYBEANS BY ASPERGILLUS ORYZAE 460. **Nasuno, Seiichi; Nakadai, Tadanobu (Noda Inst. for Scientific Research, Chiba, Japan). Hakko Kogaku Zasshi; 49: No. 6, 544-51(Jun 1971).**

A strain of Aspergillus species, which liberates a large amount of glutamic acid from defatted soybeans, was isolated from air. The isolated strain was identified as Aspergillus oryzae 460 based on various mycological and physiological properties. This strain never produced aflatoxins in the two different special media for aflatoxin production. It liberated more than twice as much glutamic acid from defatted soybeans as did ordinary shoyu molds. Among alkaline, neutral, and acid proteinases, carboxypeptidase, aminopeptidase, and leucyl-β-naphthylamidase activities, aminopeptidase activity was found to have a significant correlation with the formation of glutamic acid by the isolated strain and the related Aspergillus species. A mutant exhibiting about twice as much activity of aminopeptidase as that of the parent strain was obtained by uv irradiation. (auth)

456 VARIABILITY OF ANTIBIOTIC PROPERTIES OF LACTOBACTERIUM BREVE (ORLA-JENSEN) BERGEY UNDER THE EFFECT OF MUTAGENIC FACTORS. **Kvasnikov, E. I.; Sudenko, V. I. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 1: No. 1, 61-6(1967). (In Russian).**

A study was made of increased antibiotic activity of Lactobacterium breve under the effect of mutagenic factors (ultraviolet rays in doses of 80 to 160 erg/mm^2, dimethyl sulphate in concentrations of 0.15 to 0.3 : 1000, diethyl sulphate 2.5 : 1000, ethylenimine 0.5 to 1.0 : 1000, a combination of methyl sulphate of ethylenimine with ultraviolet rays). The greatest percentage of plus-variants is reached under the influence of successive combined action by ethylenimine (0.15 : 1000) and ultraviolet radiation (about 80 erg/mm^2). The initial strains and antibiotically active variants of lactic acid bacteria, obtained under the effect of mutagens, do not essentially differ among themselves in energy of acid formation and composition of the volatile or non-volatile acids formed by them. No correlation is observed between their antagonistic activity and capacity for acid formation. The enhanced antagonistic properties of the obtained variants are due to their great capacity for accumulation of the antibiotic substance, lactobrevine, described by the authors. (auth)

457 ULTRAVIOLET-INDUCED REPAIR SYNTHESIS IN THE DUPLICATED AND NON-DUPLICATED REGIONS OF THE ESCHERICHIA COLI CHROMOSOME. **Nakayama, H.; Pratt, A.; Hanawalt, P. (Stanford Univ., Calif.). J. Mol. Biol.; 70: No. 2, 281-9(28 Sep 1972).**

The comparative extent of repair synthesis after ultraviolet irradiation was examined in regions ahead of and behind the normal growing point in the partially replicated Escherichia coli chromosome. The results indicate that the region that had been duplicated underwent somewhat more repair synthesis than the region awaiting duplication. Recombination events between the duplicated portions of the chromosome are postulated to account for the enhanced repair in these regions. (auth)

458 INACTIVATION OF VIRUSES BY γ RADIATION. **Sullivan, Robert. Cincinnati; Univ. of Cincinnati (1972). 164p. University Microfilms Order No. 72-23,642.**

Thesis.

Viral radioresistance was studied with viruses suspended in four media and irradiated at varying temperatures in a cobalt-60 gamma radiation source. The numbers of surviving viruses at given doses of radiation were determined by a plaque forming unit assay system using an agar-medium overlay and confluent monolayers (45 cm^2) of monkey (Cercopithecus aethiops) kidney cells in 6-ounce prescription bottles. All destruction curves indicated a first-order reaction. Radiation inactivation kinetics at 0.5 C were determined for 30 viruses suspended in Eagle's minimum essential medium with nonessential amino acids in Hanks' balanced salt solution without phenol red (MEM), pH 7.0, plus 2% fetal bovine serum. Virus D values, defined as the amount

of gamma radiation in megarads required to reduce a virial population 1 $\log_{10}$, ranged from 0.39 to 0.53. The viruses studied were from the myxovirus, paramyxovirus, picornavirus, reovirus, adenovirus, papaovirus, and herpesvirus groups. Radioresistance of five viruses selected from the picornavirus and myxovirus groups was determined in distilled water at 0.5 C. D values ranged from 0.10 to 0.14. Coxsackievirus B-2 was selected for further studies. The D value of this virus irradiated in the MEM-serum medium at 0.5 C was 0.45; when irradiated in this medium at temperatures ranging from −30 to −90 C, the average D value was 0.67. When suspended in water and irradiated at 0.5 C, the D value was 0.14; at −90 C the D value was 0.53. Cooked ground beef containing coxsackievirus B-2 was irradiated at temperatures ranging from 16 to −90 C. The average D value in the cooked ground beef was 0.76. No trend with temperature was seen. The D values were 0.70 (16 C), 0.76 (0.5 C), 0.68 (−30 C), 0.78 (−60 C), and 0.81 (−90 C). Raw ground beef containing coxsackievirus B-2 was irradiated at −30, −60, and −90 C, and the D values were respectively 0.75, 0.71, and 0.68. The average D value of the virus in raw ground beef for all temperatures was 0.74. The different D values obtained with the various suspending media at varying temperatures indicated that if gamma radiation is used to inactivate viruses suspended in menstra and at temperatures other than those reported it will be necessary to investigate the rate of viral inactivation in the suspending medium and at the temperature utilized. (Diss. Abstr. Int., B)

Radiation Effects on Plants

Refer also to abstracts 429 and 435.

459 INFLUENCE OF PRESOWING γ-RAY IRRADIATION OF SEEDS ON MITOTIC ACTIVITY OF SEED BUD EPIDERMIS CELLS AND FIBERS FORMATION IN COTTON. Vlasova, N. A.; Radzhabova, D. (Inst. of Experimental Plant Biology, Tashkent). Tsitol. Genet.; 6: No. 3, 269-73(1972). (In Russian).

An effect of presowing irradiation of cotton seed of the variety 108-F, Gossypium hirsutum L., with doses of 3 kR and 10 kR was studied as applied to mitotic activity of epidermis cells and fiber formation. Mitotic activity of epidermis cells exposed to a 3 kR dose before flowering was found to be higher than in control, and fibers emerged 15 hrs later but their formation rate and percentage were higher than in control. Presowing irradiation of cotton seeds influences the mitotic activity of epidermis cells, period and rate of fiber formation, quantity of epidermis cells differentiating into fibers. (auth)

460 ANTIMUTAGENIC AND RADIOPROTECTIVE ACTIVITY OF NATURAL POLYPHENOL COMPLEX. Vinkler, G. N.; Shcherbakov, V. K. (Inst. of General Genetics, Moscow). Tsitol. Genet.; 1: No. 5, 5-9(1967). (In Russian).

Catechins and saponins, elements of a natural autoantimutagenic system (polyphenole complex), were obtained from the seeds of Vicia faba L. (dicotyledonous). These compounds revealed antimutagenic activity on Allium fistulosum L. (monocotyledonous) that testifies to a universal character of saponins and catechins. Besides its ability to inhibit the natural mutagenic activity (antimutagenic activity), the polyphenole complex showed its radioprotective effect on the cells of Allium fistulosum L., treated with x rays. The results obtained reveal an existence of naturally-formed intracellular systems of genetic protection from mutagenic factors of the environment and mutagenic metabolites of the organism itself. (auth)

461 MODIFICATION OF INJURING EFFECT OF FAST NEUTRONS ON WINTER RYE CHROMOSOMES. Pomogaibo, V. M. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 3: No. 3, 243-6(1969). (In Russian).

The results are presented of the experiments on modification of the fast neutron effect on the winter rye chromosomes. The observations were made on the percentage and character of the chromosomal aberrations in the first mitosis of seedlings. These results showed that a post-irradiation storage of seeds at indoor temperature, change of moisture content, and post-irradiation heat-shock treatment modify the cytogenetical effect of fast neutrons on chromosomes quite clearly. The mechanism of development and display of the injuring effect of fast neutrons on chromosomes is partially of a biochemical nature. (auth)

462 EFFECT OF SODIUM SALT OF NAPHTHENE ACIDS (PGA) ON THE MITOTIC ACTIVITY OF CELLS UNDER γ IRRADIATION. Gurvich, M. L. (Azerbaydzhan State Univ., Baku). Tsitol. Genet.; 2: No. 5, 400-7(1968). (In Russian).

The seeds of Allium fistulosum L. in a state of physiological rest were treated with γ rays of ^{137}Cs at a dose of 1 kR, this resulting in a delay of the first mitosis after the beginning of seed germination and inhibited the total mitotic activity for 54 to 57 hrs. The mentioned delay of mitosis is temporal and it is compensated during the following 60 to 63 hrs. Therefore, under conditions of the experiment, γ rays of ^{137}Cs cause a temporal delay of the mitosis mechanism resulting in the synchronization of the cell population in the apical meristem of shoots. When germinating the irradiated seeds in the naphthalene-acetic acid (PGA) solutions ($C_{13}H_{24}ONa$) of $1 \cdot 10^{-4}$ and $1 \cdot 10^{-3}$% concentrations, the intensification of the mitotic activity for all the terms of the material analysis was observed, the solution of $1 \cdot 10^{-3}$% concentration causing a more considerable stimulation of mitosis. A similarity was observed in the dynamics of the mitotic index changes in the irradiation variant and in the variants with PGA application. The difference was a higher level of the mitotic activity with PGA application. The effect of stimulation considerably surpasses the anti-radiation effect values of compounds known from the literature. The inhibition of mitosis by seed irradiation and mitosis stimulation under PGA effect are not specific and probably they are connected with the effect of applied external factors on the process of the preparation of the cell to the mitosis. (auth)

463 EFFECT OF FAST NEUTRONS ON THE SEEDLINGS OF DIPLOID AND AUTOTETRAPLOID WINTER RYE. Safin, M. K.; Demchenko, V. E. (Inst. of Botany, Kiev). Tsitol. Genet.; 2: No. 3, 238-43(1968). (In Russian).

A cytogenetic analysis was carried out of rye cells irradiated during their division. Rye seedlings of the following varieties were treated with fast neutrons: Vyatka (2x = 14 and 4x = 28), Tatsinskaya blue (2x = 14), and Petkus (4x = 28). The first post-radiation mitosis was investigated. In order to ascertain the regularities of alterations of the chromosome apparatus (diffuse or physiologic effect of radiation) the seedlings were treated with 10 and 60 rad; fixation was carried out over the range of 10 to 150 min after the radiation. Investigations showed that the quantity of anaphases with the damaged chromosome apparatus was higher in seedlings of tetraploid rye than in those of diploid rye. Increased sensitivity of 28-chromosome rye is also manifested in the earlier appearance of disturbances as compared with 14-chromosome rye. There were no noticeable differences between the doses as to the quantity of cells with damages. However at the dose of 60 rad, an earlier cessation of mitosis was observed as well as a longer absence of the second postradiation mitosis. The material presented in the article gives the ground to conclude that immediately after irradiation of the dividing cells the decisive role in the radiobiological effect belongs not to the nucleus but to the cytoplasm. (auth)

464 PLANT GENETIC TUMORS. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). Progr. Exp. Tumor Res.; 15: 138-64(1972).

An effort was made to review the reported cases of genetic tumors in plants occurring both within species and in species hybrids. More is known about the genetically tumor-prone hybrids of Nicotiana than any other plant material. Hence, this literature is reviewed in detail with respect to the cytogenetic basis, tumor morphology and histology, effects of ionizing radiations, physiology, and biochemistry, and the use of tissue cultures. Finally, a synthesis is attempted to explain tumor formation in terms of gene activity. (auth)

465 SENSITIVITY OF DIFFERENT VARIETIES AND F_1 HYBRIDS OF SPRING BARLEY TO GAMMA RAYS. Manzyuk, V. T.; Kozachenko, M. R. (Inst. of Water Propagation, Selection, and Genetics, Kharkov). Tsitol. Genet.; 2: No. 4, 308-13 (1968). (In Russian).

A comparative study was carried out of radiosensitivity of various F_1 hybrids and their parental varieties in filmy spring two-rowed barley. Dry seeds were treated with 10 kr of ^{60}Co gamma-rays with radiation intensity of 640 R/min. The different varieties and hybrids reacted differently to radiation at the different stages of their development as is shown by the changes of their different indices. Both early and late varieties, obtained by individual selection and developed by hybridization, were among the highly radiosensitive ones. F_1 hybrids have a different radiosensitivity level, which depends on the radiosensitivity of their parental varieties and on the certain properties of F_1 hybrids. Three varieties that were studied showed a slight decrease of pollen fertility due to pre-sowing seed irradiation. As a result of irradiation the varieties and hybrids showed some spike and stem morphological changes. (auth)

466 STUDY OF THE FIRST GENERATION OF BARLEY AFTER TREATMENT WITH RADIOPROTECTORS AND GAMMA RAYS. Levenko, B. A. (Inst. of Botany, Kiev). Tsitol. Genet.; 2: No. 4, 314-18(1968). (In Russian).

Studies were conducted on the first generation grown from the seeds of two spring barley varieties soaked in 0.005 M and

0.05 M solutions of cysteine, β-mercaptoethylamine, tiourine, ferrous chloride and ferrous chlorate and then irradiated by 10 krad of gamma-rays. In control variants a depressing effect on almost all of the studied characters is observed. A protective effect of cysteine (especially in 0.05 M concentration), β-mercaptoethylamine and ferrous chloride (especially in 0.05 M concentration) on the lethality and plant height is found. All substances (except 93) give a protective effect on the number of stems with fertile heads. No clear effect on the number of fertile seeds per head or on the number of stems with sterile heads was found. A different reaction of two barley varieties was found when seeds were treated with tiourine and ferrous chlorate before irradiation with 10 krad of gamma-rays. (auth)

467 INDUCED MUTATIONS AND STERILITY OF WINTER WHEAT POLLEN. Savchenko, N. I.; Lastovich, A. S.; Belous, V. E.; Seraya, L. V. Tsitol. Genet.; 3: No. 5, 395-401(1969). (In Russian).

Mutants with economically useful characters were obtained as a result of individual-family selection in a winter wheat variety Bezostaya 1, treated with 10 kr of γ-rays. The selected male-sterile material with regular meiosis was used for the establishment of CMS (cytoplasmic male sterility) sources. Biochemical investigations of pollen and anthers of the male-sterile mutant lines show that pollen degeneration takes place here in the same way as in other sources of CMS. (auth)

468 EFFECT OF ELEVATED TEMPERATURE, γ-RAYS, and FAST NEUTRONS ON THE VARIATION OF QUANTITATIVE CHARACTERS OF HARD WHEAT IN M_2. Sen'ko, V. P. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 3: No. 5, 466-7(1969). (In Russian).

The effect was studied of elevated temperatures (30°C for 40 days and 40°C for 30 days), γ rays (10 krad), and fast neutrons (1 krad) on the survival and variation of quantitative characters of wheat in M_2. A change of these characters was established in the directions of plus and minus under the effect of ionizing irradiation. Besides, ionizing irradiation caused a decrease in the viability of plants in M_2. Elevated temperature decreased viability only slightly. (auth)

469 INFLUENCE OF SEED STAGE DEVELOPMENT AND GROWING CONDITIONS ON THE GENETIC EFFECT OF IONIZING RADIATION IN WHEAT. Sadykhov, A. M. (Inst. of Genetics and Selection, Baku). Tsitol. Genet.; 2: No. 4, 299-307(1968). (In Russian).

To study influence of seed stage development on the genetic effect of ionizing radiation the seeds of wheat were taken at different stages of their embryonic development. These stages were 8, 12, 16, 20 days after flowering and at the complete ripening of the seed. Three varieties of durum wheat and two varieties of bread wheat were used in the experiment. The seeds were treated with 10 and 15 kR of gamma-rays and control ones were sown in five different zones of Azerbaijan, at 80, 420, 700, 1610 and 2050 meters above sea-level respectively. The experiments showed that the seeds at the early stages of their embryonic development are more sensitive to the radiation than the ripe ones. The radiation of the seeds negatively affected their field germinating capacity and the growth of the plants. Only in two cases under the conditions of Shemakha it was observed that the radiation in doses of 10 kR and 15 kR had a stimulating effect on the growth of plants, ear size and on the quantity of the spikelets in the ear. As a result of the gamma-ray effect on the seeds of early embryonic age a series of the speltoid and persicoid mutants was obtained as well as numerous forms with various changes of the ear characters. The frequency of the mutations was considerably greater under the mountain and Alpine conditions. Among the mutants the forms were selected which are used for the breeding purposes. (auth)

470 EFFECTS OF DELAY BETWEEN HARVEST AND IRRADIATION AND OF STORAGE TEMPERATURES ON THE SPROUT-INHIBITION OF ONIONS BY GAMMA IRRADIATION. Chachin, Kazuo; Ogata, Kuniyasu (Osaka Prefectural Univ., Sakai, Japan). Nippon Shokuhin Kogyo Gakkaishi; 18: No. 8, 378-82(Aug 1971). (In Japanese).

Senshu-ki onions were irradiated at the ranges of 1 to 15 Krad. Gamma irradiation at the doses of 7 and 15 Krad inhibited almost completely the sprouting of onions that were irradiated on the 20th day after harvest or irradiated after 1⅓ months of storage at 0°C before irradiation. In onions that were irradiated at the doses of 7 and 15 Krad after 3⅓ months of storage at room temperature, there was found considerable sprouting, showing approximately 50% of sprouting. Even when irradiation was carried out about 2 months after harvest, a dose of 5 Krad was sufficient to prevent sprouting during subsequent storage at room temperature. Onions irradiated at a dose of 1 Krad and stored at room temperature sprouted during the storage but showed thin sprouts, whereas in the onions of 1 Krad stored at 6°C after irradiation subsequent sprouting was prevented sufficiently. Irradiation up to 15 Krad did not affect the rates of weight loss and rotting of onions until the unirradiated onions sprouted. There were found the dead cells (darkened area) in both inner buds and disks in the early stage of the injury of irradiated onions. The inner buds (or internal sprouts) in sprout-inhibited onions by irradiation darkened during subsequent storage. (auth)

471 APPLICATION OF THE TARGET THEORY TO THE INVESTIGATION OF PHOTOSYNTHETICALLY ACTIVE CHLOROPLAST UNITS. I. HILL'S REACTION WITH FERRICYANIDE. Grodzinskii, D. M.; Lutsishina, E. G. (Inst. of Plant Physiology, Kiev). Tsitol. Genet.; 3: No. 5, 440-3(1969). (In Russian).

Chioroplasts isolated from spinach leaves were lyophilized and irradiated with γ-rays of Co_{60}, x-rays, neutrons (14 MeV) and particles (4.7 MeV) at doses of 10^4 to 5×10^6 rad. After suspending the chloroplasts in Tris-buffer-HCl (pH 8.0) the intensity of reduction of ferricyanide was determined. Dosage dependence of the photoreduction reaction has an exponential character and is independent of the intensity of the dose but dependent on the type of radiation. Thus the target theory can be applied to the reaction studied. The shape of dosage-effect curves corresponds to a one-hit process. The size of photosynthetically active units responsible for the photoreduction of ferricyanide and calculated according to the theory of D. E. Lee is as follows: complete sensitive volume 3.6×10^5 Å^3; molecular weight 2.7×10^5, amount of chlorophyll per target is about 400. (auth)

472 CHROMOSOME ABERRATIONS AND VISIBLE MUTATIONS IN WHEAT INDUCED BY RADIATION AND CHEMICALS. Shkvarnikov, P. K.; Kulik, M. I.; Chernyi, I. V. (Inst. of Botany, Kiev). Tsitol. Genet.; 1: No. 1, 23-33(1967). (In Russian).

Dry seeds of hexaploid wheat were irradiated with fast and thermal neutrons, x-rays, gamma-rays or treated with ethyleneimine (EI), dimethylsulfate (DMS), ethyl methane sulfonate (EMS) and hydroxylamine (HA). The highest frequency of chromosome aberrations (96.8%) was observed after treatment with neutrons while that induced with other agents ranged from 88 to 2,6%. The chromosome aberration frequency induced by 0,05% EI was equivalent to that induced by 5 kr gamma-rays and effects induced by 0.1% DMS and 1% EMS were half the magnitude. The maximum chromosome aberration frequency induced by HA was only 2.4 times higher than in the control. The highest visible mutation frequency (48%) was observed after treatment with fast neutrons. The second place was occupied by mutation frequency (37%) induced with HA while the frequency of the mutations induced by other agents ranged from 30% (with DMS) to 19% (with gamma-rays). The ratio of visible mutations to chromosome aberrations induced by HA was as high as 26,1 : 1 while after other treatments this ratio ranged from 0,21 : 1 to 1,4 : 1. Fast neutrons gave the smallest relative mutation yield of practical value. Marked differences were also observed in the mutation spectrum induced by different agents. Thus, speltoid, light-green and sterile mutants were absent after EI treatment while they appeared frequently after treatment with EMS, gamma-rays and neutrons. But early heading mutants were induced more frequently by EI than by EMS, gamma-rays and neutrons. The frequency and spectrum of mutations as well as the mutation yield of practical value were also altered by combining radiation and chemical treatment. Thus the combination of neutron and EMS treatment did not influence the total mutation frequency but changed the mutation spectrum and decreased the mutation yield with valuable characters. Gamma-irradiation combined with EI treatment, on the contrary, increased the yield of these mutation types. (auth)

473 VARIABILITY OF GLUTEN CONTENT AND QUALITY IN THE SEEDS OF INTRASPECIFIC HYBRIDS OF BREAD WHEAT INDUCED BY GAMMA- AND X-RAYS. Maistrenko, O. I.; Pal'chikova, G. M. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Tsitol. Genet.; 1: No. 1, 34-40(1967). (In Russian).

A study was made of gluten content and quality in spring wheat plants induced by the 5 kr of gamma- and x-rays acting on F_1 hybrid seeds. Irradiation induced in M_2 of three investigated populations a regular increase of variability indices of raw gluten: range limits, variation coefficient. The populations obtained as a result of crossing the most contrasting varieties with respect to this character demonstrated the greatest variability. In each M_2 population the authors found the forms, comprising 0.4 to 2.9% which exceeded the best plants of the control variants in gluten content. No similar effect was observed with respect to gluten quality. It is perhaps connected with the magnitude of the irradiation doses. The authors have elaborated a micromethod for estimating the content and quality of gluten in individual wheat plants

by analyzing a small number of grains in the middle part of the ear. This method can be successfully applied for investigation of mutational variability of gluten characters. (auth)

474 EFFECT OF PROTECTIVE COMPOUNDS AND OTHER FACTORS ON GROWTH AND SURFIVAL OF WINTER RYE SEEDLINGS GROWN FROM SEEDS IRRADIATED WITH FAST NEUTRONS. Pomogaibo, V. M. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 2: No. 6, 507-9(1968). (In Russian).

The results are presented of the experiments on modifications of the biological effect of fast neutrons in seed treatment of winter rye. The growth of seedlings was observed. The analysis of the results showed that post-irradiation storage of seeds, seed moisture content, and post-irradiation heat-shock treatment modify the biological effects of fast neutrons considerably. (auth)

475 CHANGES IN FLAVOR COMPONENTS OF ONION INDUCED BY GAMMA IRRADIATION. Nishimura; Hiroyuki; Asahi, Akio; Fujiwara, Kazuya; Mizutani, Junya; Obata, Yataro (Hokkaido Univ., Sapporo). Agr. Biol. Chem. (Tokyo); 35: No. 12, 1831-5(Dec 1971).

The effect of γ irradiation on the flavor of onions (Senshu Yellow) associated with sprout inhibition was investigated. The relative amounts of propionaldehyde, n-propyl mercaptan, and di-n-propyl disulfide in onions stored for 0, 5, 10, 20, and 30 days, respectively, after irradiation were estimated by measurement of peak areas of gas chromatograms. It was observed that the lachrymatory character and the pungent flavor were decreased by γ irradiation (remarkably at 70 and 700 Krads). In this connection, the amounts of propionaldehyde and di-n-propyl disulfide were decreased with increasing radiation dose and storage period at room temperature (20 to 25°C) and at low temperature (4°C). Moreover, it was observed that the sweetness had been decreased by γ irradiation, but the amount of n-propyl mercaptan was increased with radiation dose and storage period. Therefore it seems that there is no correlation between the sweetness of onion and the amount of n-propyl mercaptan. (auth) (Japan)

476 NON-LINEAR RESPONSE OF SURVIVAL TO VARIATION IN EXPOSURE TIME IN WHEAT. Bottino, P. J.; Sparrow, A. H. (Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol.; 22: No. 4, 411-16(Oct 1972).

In a simulated fall-out experiment, a series of 8 day old wheat seedlings (Tritium aestivum "Indus") were irradiated with ^{137}Cs and irradiation over a dose range 0 to 13 Krad for times ranging from 0.5 to 320 hr. From the results, a three-component survival curve was suggested (1) an approximate linear response between 0.5 and 16 hr, where the LD_{50} increased gradually from 1730 to 4260 R (2) between 16 and 96 hr, where the LD_{50} increased very sharply from 4260 to 10,651 R. (3) From 96 to 320 hr where the LD_{50} decreased sharply from 10,651 to 3874 R. (UK)

477 MUTAGENIC EFFECT OF EXTRACT FROM SEEDS IRRADIATED WITH FAST NEUTRONS. Pomogaibo, V. M. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 3: No. 4, 373-4(1969). (In Russian).

The extracts from winter rye seeds irradiated with fast neutrons were found to have an injuring effect on chromosomes. It permits to affirm that sparsely and densely-ionizing radiations have a common mechanism of the biological action. This mechanism consists partially in the interaction of chemical substances, forming in the irradiated seeds (radiometabolites) with cytoplasmatic and nuclear material of the cells during the period of the seed germination. (auth)

478 MUTAGENOUS EFFECT OF EXTRACTS OF SEEDS TREATED WITH IONIZING RADIATION. Shkvarnikov, P. K.; Shmeleva, Yu. F. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 3: No. 2, 147-9(1969). (In Russian).

The mutagenous efficiency of extracts from irradiated seeds was investigated. For this purpose the seeds of hexaploid spring wheat treated with 25, 30, and 35 kR of γ rays were germinated in Petri dishes together with unirradiated ones of the same variety and sampling. Unirradiated seeds that were germinated in a separate Petri dish served as a control sample. The unirradiated seeds were considerably affected with substances diffusing from the irradiated seeds. This effect was manifested in an essential inhibition of germinating the unirradiated seeds and 3 to 7-fold increase in the frequency of chromosome aberrations in them as compared with the control sample. The frequency of chromosome aberrations increased with an increase of the irradiation dose of seed-donors. (auth)

479 DEVELOPMENT OF LILAC EMBRYOS IRRADIATED WITH NEUTRONS. Uzenbaev, E. Kh.; Ibragimova, G. D. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 1, 12-14(1972). (In Russian).

The effect of fast and thermal neutrons on the development of lilac embryos (Syringa villosa) and the procambial strand in the axial organs of the embryos was studied. A dose of 100 R had a positive effect on embryo development, as judged by the intensity of cell division in all parts of the embryo, and noticeable growth and development in comparison with the controls. A dose of 300 R caused some aberration in the cotyledons, root parts, and the development of the procambium. (K.S.W.)

480 GENETIC EFFECT OF NATURAL RADIOACTIVITY. Zagruznyi, P. L. Tsitol. Genet.; 2: No. 1, 72-4(1968). (In Russian).

The soaking of seeds in radioactive mineral water increased their growth and crop yields of the grown plants. The possibility was studied to use radium-radon waters with increased uranium, radium, and radon concentration as means for inducing radiomutations. As a result of treatment of wheat and barley seeds with radioactive mineral waters, the author succeeded in obtaining a number of economically useful mutants of these plants. (auth)

481 EFFECTS OF RECURRENT SEED IRRADIATION ON GENETIC VARIABILITY AND RECOMBINATION IN COTTON, GOSSYPIUM HIRSUTUM L. Senlogiou, Nicolaos Argyrios. Raleigh, N. C.; North Carolina State Univ. (1972). 41p. University Microfilms Order No. 72-24,101.

Thesis.

The effect of five cycles of seed irradiation with 10 kR of γ rays per cycle on the means, variances, and covariances of a synthetic cotton (Gossypium hirsutum L.) population was studied. Means were lower after the treatment for the traits previously selected for high values, and were higher for the traits previously selected for low values. Means of traits previously selected for intermediate values remained unaffected. Variances were generally, but moderately increased. The effect on correlations between traits was rather small. Expected gains from selection were higher in the treated population, but the increased gain could hardly, if at all, compensate for the lower means of that population. The changes effected by the treatment are deemed rather small. The reason is thought to be the low doses of radiation used. (Diss. Abstr. Int., B)

482 RADIOINDUCED STRUCTURAL CHANGES AND MEIOTIC ABBERRATIONS IN SORGHUM. Ramulu, K. S. (Agricultural Coll. Coimbatore, India). Cytologia (Tokyo); 36: No. 2, 229-36(Jun 1971).

Cytological observations were made in M_1 plants treated with radiations (x and gamma rays), chemical mutagens (EMS, MMS, DES, and NEU), and their combination treatments to study the effects on types of chromosome associations and the frequency and type of other nuclear and nucleolar anomalies in three cultivated varieties (Co. 11, Co. 12, and Co. 18) of Eu-Sorghum. Reciprocal translocations having a ring or rod configuration occurred in higher frequency than the other types of structural changes. A positive correlation between the percentage of M_1 plants carrying chromosomes with interchanges and the dose of mutagens was observed. The treatments with radiations induced not only a greater frequency of interchanges per cell but also a higher percentage of pollen mother cells with quadrivalents than treatments with chemical mutagens. The effect on disturbances in meiosis as judged by the chromosome association was measured by the mean number of univalents, bivalents, and multivalents per cell. The combined treatments did not lead to any additive effect in inducing chromosome breakages. Meiotic anomalies other than translocations comprised mostly laggards, bridges tripolar spindles, micronuclei, and multinucleoli. The percentage of pollen mother cells with meiotic disturbances was on the increase with increase in dose of the mutagens. Radiation treatments induced the maximum frequency of pollen mother cells carrying meiotic anomalies as compared to treatments with chemical mutagens. (auth)

483 BREEDING OF A NEW STRAIN OF AQUATIC RICE WITH RADIATION. Futsuhara, Y. (Nagoya Univ., Japan). Nogyo Oyobi Engei; 46: No. 6, 861-4(Jul 1971). (In Japanese).

Radiation breeding in Japan has made rapid progress since establishment of a gamma room and a gamma field. Fujiminori, a variety of aquatic rice, is a very excellent and precocious species enabling good harvest, and having cold- and disease-resistance, but not enough falling resistance. Doses of 20 KR and 30 KR with ^{60}Co-γ ray were given to dry seeds of the Fujiminori rice to cultivate 50,000 plants of 1467 strains of X_2. A total of 112 varieties with short stems was observed, and the appearance rate was 7.6%. Among these, two promising kinds of X_4 species with the characteristics of the original strain and excellent falling-resistance were chosen, and the species were taken from the 20 KR group and named Reimei. This variety has been cultivated practically for seven years, and in 1970, 68% of a whole rice field in Aomori Pref. was this variety. (Japan)

484 EFFECT OF GROWTH REGULATORS ON GAMMA RAY TREATED BARLEY SEEDS. Bhan, A. K.; Banerjee, S. K. (Indian Agricultural Research Inst., New Delhi). Sci. Cult. (Calcutta); 38: No. 2, 85-6(Feb 1972).

In view of the fact that plant growth regulators are lost following irradiation, studies involving the pretreatment of plants with high concentrations of gibberellic acid and kinetins were undertaken and the radioprotective properties of these growth regulators were determined. Freshly harvested barley seeds were soaked in distilled water (controls), gibberellic acid, or kinetin solutions and exposed to a ^{60}Co γ source for a dose of 15 kR. Following germination, mitotic index, chromosomal aberrations, and viability of embryonal axis were determined as criteria for radiation damage. In the control (γ-irradiated only) plants, mitotic index was appreciably reduced whereas it was virtually normal in treated plants, the frequency of chromosomal aberrations was 3 to 4 times higher than in the gibberellic acid- or kinetin-treated plants, and seed viability losses were 11% in controls while in the treated seeds losses were only 1 to 4%. The presumptive role of gibberellic acid and kinetin in the radiation-treated seeds in either stimulating physiological activity or in repair mechanism of chromosomes was not worked out in detail. (E.R.B.)

485 RELATIVE BIOLOGICAL EFFECTIVENESS OF 14.1 MeV NEUTRONS FOR SOMATIC MUTATIONS INDUCED IN THE DIPLOID OAT SEEDS PRESOAKED IN WATER. Ikushima, Takaji (Kyoto Univ.). Jap. J. Genet.; 47: No. 4, 265-75(Aug 1972).

Seeds of a genetic stock of diploid oats (2n = 14) that is heterozygous for the plant color (al/+) were presoaked for periods ranging from 0 to 48 hrs and then exposed to x rays or 14.1 MeV fast neutrons. The RBE of 14.1 MeV fast neutrons for the reduction of seedling height was 11.5 in dry seeds, while much lower RBEs of 2.4, 1.9, 1.3, and 1.2 were obtained from 6, 12, 24, and 48 hr presoaked seeds, respectively. The RBE obtained from dry seeds for the induction of somatic mutations was 24, but the corresponding values were 4.0, 2.3, 1.9, and 1.7 in 6, 12, 24, and 48 hr presoaked seeds, respectively. Decrease of RBE values in wet seeds was thus clearly demonstrated and lower values are closer to those from other organisms than to those from dry seeds of higher plants. The results show clearly that water content is one of the major modifying factors of RBE values. Other possible modifying factors were also discussed. (auth)

486 PRODUCTIVITY OF PHOTOSYNTHESIS IN SCOTS PINE (PINUS SILVESTRIS L.) SEEDLINGS GROWN FROM SEED IRRADIATED BY X RAYS. Zelawski, W.; Nalborczyk, E. (Warsaw Agricultural Univ.). Acta Soc. Bot. Pol.; 40: 413-21(1971).

Dry matter accumulation, growth, photosynthesis, and respiration were investigated in pine seedlings grown in water culture from seed irradiated with various doses of x rays. The stimulating effect of x-ray treatment appeared in formation of assimilatory organs and in accumulation of dry matter in various parts of a plant. Changes in photosynthesis and respiration activity seem to be rather secondary effects of growth stimulation or inhibition. Changes in growth, dry matter accumulation, photosynthesis and respiration of plants grown from seed irradiated by x rays are investigated in relation to the influence of ionizing radiation on physiological processes in plants. On the other hand, seedlings grown from seed after x-ray treatment seemed to be an interesting object for studying photosynthetic productivity since stimulatory and inhibitory effects are obtainable here on plant material differentiated by the influence of only one factor i.e., various doses of radiation. (INIS)

Radiation Effects on Animals

Man

Refer also to abstract 2227.

487 (COO-3013-22) BIOLOGICAL EFFECTS OF SMALL DOSES OF RADIATION. Fabrikant, Jacob I. (Connecticut Univ., Hartford, Dept. of Radiology). 1971. Contract AT(30-1)-4244. 46p. (CONF-710726-1). Dep. NTIS.

From 13th annual meeting of the American Association of Physicists in Medicine; Houston, TX. (6 Jul 1972).

A review is presented of the effects of low dose radiation on the reproductive biology, growth, and development of mammals in relation to problems of diagnostic x-ray exposure. Some topics discussed are: estimation of annual genetically significant dose received by the human population as a whole from diagnostic x-ray exposures; genetic hazards to gonads of fetus and ovaries of mother following x-ray exposure during pregnancy; radioinduced cell killing in relation to effects on the developing ovum and fetus; experiments with animals in relation to genetic hazards and induction of leukemia and childhood malignancies during obstetrical radiology; extrapolation of data from mice to humans; increased incidence of human abortions and stillbirths following fetal irradiation of mothers at Hiroshima, Nagasaki, and the Marshall Islands; effects of radiation dose on mutation rates in spermatozoa and oocytes of mice; hazards of diagnostic radiation to children; experiments on radiation mutagenesis in Drosophila; ICRP recommendations concerning radiological examinations of abdomen and pelvis of women of reproductive age; and age and dose dependence of radioinduced cancer. (H.L.W.)

488 (LBL-1011) BIOLOGICAL EFFECTS DUE TO SINGLE ACCELERATED HEAVY PARTICLES AND THE PROBLEMS OF NERVOUS SYSTEM EXPOSURE IN SPACE. Tobias, C. A.; Budinger, T. F.; Lyman, J. T. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jul 1972. Contract W-7405-eng-48. 30p. (CONF-720556-1). Dep. NTIS.

From COSPAR conference; Madrid, Spain (10 May 1972).

A review is presented of studies on light flashes and similar visual phenomena experienced by astronauts during space flight. Studies on light sensations from heavily ionizing particles included exposure to fast neutrons in the 300 to 600 MeV energy range, fission neutrons from ^{252}Cf, helium ions, and nitrogen ions. Studies on light sensation from relativistic particles included production of light flash events by energy transfer in the ionization track, by light from Cherenkov irradiation, and by fluorescence induced in some part of the eye. Discussions are also presented of light sensations from x rays and the nature of the critical physical interactions. (H.L.W.)

489 (ORNL-TM-3986) MEDICAL X-RAY DOSE ESTIMATION PROGRAM. Progress Report for Period Ending August 31, 1972. Poston, J. W.; Warner, G. G. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 17p. Dep. NTIS.

Modifications of an existing code for internal sources were completed allowing the calculation of absorbed dose to specific organs in an anthropomorphic phantom due to external beams of photons. These modifications include the addition of a thyroid gland containing 10 mg of iodine, the simulation of a diagnostic table adjacent to the front or rear of the phantom, and a region to allow estimation of the absorbed dose to the lenses of the eyes. Two sets of calculations, using a 4 × 4-cm beam of photons, were performed. Photon energies chosen for these calculations were 30 and 55 keV. Data were extracted from computer printouts and put in a form that should facilitate the future analysis and use of the basic data. (auth)

490 RADIATION PROTECTION IN ROENTGEN DIAGNOSIS. Fankhauser, H. Oesterr. Schwesternztg.; 24: 255-64(1971). (In German).

Radiation protection in x-ray diagnosis is surveyed from a general standpoint. With respect to personnel protection, the following points are made: the control panel should not be located in the radiation area; if a patient needs support, the supporting person should not be a professionally exposed person. If necessary, films should be held in position by the patient himself; distance is the best radiation protection; while working in the radiation area, lead aprons must be worn. If assistants and nurses follow established rules of radiation protection, the radiation burden of patients can be significantly reduced, and the personnel itself should receive not more than 0.1 rem per week. (H.B.G.)

491 POPULATION DOSE IN MAN-REM BY THE ENVIRONMENTAL RADIATION DUE TO NUCLEAR POWER PRODUCTION. Tajima, Eizo (Rikkyo Univ., Tokyo); Ichikawa, Ryushi; Kuwashima, Kaneomi. Nippon Genshiryoku Gakkaishi; 14: No. 3, 131-7(Mar 1972). (In Japanese).

An estimate is presented on the exposure of the Japanese population to environmental radioactivity from nuclear power plants and fuel reprocessing facilities. There are two main sources of radiation exposure to the population. Firstly, there is the contribution from the atmospheric ^{85}Kr and hydrospheric ^{3}H that originate from world-wide nuclear power production. The second component of population exposure derives from the atmospheric and coastal releases of both air-borne and liquid radioactive wastes from nuclear facilities installed in Japan. Assuming that the nuclear power generating capacity of the whole world will be 4,300 GWe and that for Japan alone will be 220 GWe in the year 2000, it is estimated that the above-mentioned exposure pathways will give rise to a dose rate of 1.7×10^4 man-rem/yr for the Japanese population. (auth)

492 BASIC X-RAY PROTECTION IN DENTAL RADIOLOGY. Manson-Hing, L. R. (Univ. of Alabama, Birmingham). J. Ala. Dent. Ass.; 55: 15-21(Jul 1971).

The dangers of overexposure to ionizing radiation are well documented. In the dental office, the x-ray machine produces a possible hazard to the patient, the operator, and persons in the immediate vicinity of the x-ray room. The exposure of patients to dental x rays can be minimized through the use of fast radiographic films, proper collimation and filtration of the x-ray beam, and the use of gonadal shields, open end cones, good film exposure technic, increased tube patient distance, recessed filters, and lead lined cones. Reduction of operator exposure is achieved by avoiding the primary beam of radiation, standing at least six feet from the patient and in the least dangerous position relative to the patient, not holding the machine tube head and if possible standing behind a shield. Protection of people in the immediate environs is achieved through adequate wall shielding. (auth)

493 GENETIC DOSE FROM DENTAL RADIOLOGY. Smith, N. J. D. (King's Coll., London). Brit. J. Radiol.; 45: No. 538, 733-6(Oct 1972).

The results of a survey of radiation protection in the surgeries of 114 dentists in practice in South East England showed that a significant percentage of dentists and their staff receive measurable doses on their film badges. The gonad dose of dentists and assistants was assessed from the results of film badge monitoring and the genetic dose to the population of the United Kingdom derived from this source was estimated at 0.02 mrad person per year. (UK)

494 RADIOSENSITIVITY OF NORMAL HUMAN RECTAL MUCOSA TO IRRADIATION IN HYPERBARIC OXYGEN. Wiernik, George; Perrins, David (Churchill Hospital, Oxford). Brit. J. Radiol.; 45: No. 538, 737-44(Oct 1972).

A method is described for assessing the oxygen effect during irradiation of normal human rectal mucosa. The response to irradiation in hyperbaric O_2(3 atm, 304 KNm^{-2}) and air was compared by histological examination of serial biopsies taken from patients being treated in a controlled trial of hyperbaric O_2 as an adjunct to radiotherapy for advanced pelvic tumors. Patients received 10 fractions of ^{60}Co teletherapy, a tissue maximum dose of 425 rads twice/week to a total of 4,250 rads. In each specimen epithelial and goblet cells were counted, as were the cells undergoing mitosis. By pooling all the results for specific times after irradiation, consistent curves were obtained which indicate that the total number of cells is unaffected, whether the irradiation is given in air or in oxygen. There was a depression in mitoses in the O_2 series when compared with the air series and a reciprocal elevation of the goblet cell component. The evidence suggested that there was a qualitative, but no quantitative, difference in cellular damage following the irradiation treatment of patients in the two groups. This was not of sufficient magnitude to require adjustment of dose when treating in hyperbaric O_2. (UK)

495 CHROMOSOME ABERRATIONS IN LYMPHOCYTES FROM PATIENTS EXPOSED TO THORIUM DIOXIDE. Woodliff, H. J.; Cohen, G.; Gallon, W. (Royal Perth Hospital, Western Australia). Med. J. Aust.; 2: No. 14, 768-71(30 Sep 1972).

The peripheral blood leukocytes of two patients with a history of thorium injections were cultured and their chromosomes analyzed. The first patient, a male born in 1917, died of disseminated hemangiosarcoma in 1970, when aged 53 years. In 1947, Thorotrast had been injected into the left carotid artery and some had escaped into the tissues, giving rise to a granuloma. On three occasions, metaphases showing radiation damage were detected; dicentrics, acentric fragments, rings and marker chromosomes were seen. The second patient, a female born in 1928, is in apparently good health. In 1957, a phlebogram using Thorotrast was performed and in 1970, an x-ray examination revealed the presence of Thorotrast in the spleen. A single examination revealed metaphases showing dicentrics, tricentrics, rings, acentric fragments and marker chromosomes. The literature of Thorotrast chromosome damage is reviewed and the significance of the findings discussed. (auth)

496 SEVERE ERYTHEMA MULTIFORME (STEVENS–JOHNSON SYNDROME) FOLLOWING TELECOBALT THERAPY. Nawalkha, P. L.; Mathur, N. K.; Malhotra, Y. K.; Saksena, H. C. (Sardar Patel Medical Coll., Bikaner, India). Brit. J. Radiol.; 45: No. 538, 768-9(Oct 1972).

A summarized case history is presented of erythema multiforme (Stevens–Johnson syndrome) following telecobalt γ therapy (dose regime not detailed). The patient was a 35 year old female Hindu, treated for carcinoma of the cervix, Stage III. (UK)

497 ON DICENTRIC ABERRATION YIELDS IN 50-MeV PROTON-IRRADIATED HUMAN PERIPHERAL LYMPHOCYTES. Todorov, S. L.; Grigoriev, Yu. G.; Rizhov, N. I.; (and others) (Inst. of Radiology and Radiation Hygiene, Sofia). Experientia; 28: No. 8, 973-4(15 Aug 1972).

For studies on biological dosimetry, whole blood was exposed to 50 MeV protons immediately after vena puncture. Fixation time was at 52 hr after phytohemagglutinin stimulation. An analysis of metaphase chromosomes was made and a graph is presented to show the average number of dicentrics per cell as a function of dose after irradiation. Dicentric aberrations predominated and dicentric yields only were used in estimating dose-response relationships. An equation is presented for the regression curve that fits statistical treatment of data. (H.L.W.)

498 REVIEW OF ICRP RECOMMENDATIONS FROM THE STANDPOINT OF HEALTH SUPERVISION. Imahori, Akira (Tokyo Univ.). Radioisotopes (Tokyo); 20: No. 12, 684-8 (Dec 1971). (In Japanese).

With the development of the atomic energy industry, the number of people engaging in radiation works increased rapidly. Fundamental guiding principles for protection against radiation are derived from ICRP recommendations internationally and nationally. The first recommendation in 1928 took up skin injury, degeneration of internal organs, and change in peripheral blood, and prescribed working conditions for workers dealing with x rays and radium. The recommendation in 1931 added new items concerning physical check-up and blood examination for the workers and limitation or prohibition of working according to the results. The recommendation in 1934 proposed for the first time the concept of tolerance dose. Content of the recommendation in 1950 was more substantial than before, and it was adopted as the guiding principle for legislation regarding radiation. Range of the radiation injuries was extended, and permissible dose was introduced. Methods for personnel dose monitoring were recommended. The recommendation in 1954 included for the first time the recommendations by four special committees as well as general recommendations. The recommendation in 1958 revised the previous recommendations drastically. Maximum allowable integrated dose was proposed for hematogenic and generative organs, and the allowable dose for general public was mentioned. Importance of pre-employment examination was emphasized. In the recommendation in 1962, limitations of exposure for women and pregnant women were added. In the newest recommendation in 1965, revision was made on delayed radiation effect, health control as industrial medicine, exemption of personnel monitoring and health control for workers, and necessity of special health control. (Japan)

499 STUDIES ON THE EFFECT OF X IRRADIATION ON THE SERUM LYSOZYME ACTIVITY AND THE PROTECTIVE EFFECT OF CRYSTALLIZED EGG WHITE LYSOZYME. Matsuba, Yutaka (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho; 88: 81-106(Apr 1971). (In Japanese).

Changes in the serum activity of lysozyme, an enzyme hydrolyzing some mucopolysaccharides, due to ionizing radiation to rabbits and patients treated with ^{60}Co were observed. In addition, the protective effect of lysozyme against irradiation was studied under various conditions. In the whole-body x irradiation of rabbit, a simple 800 R radiation revealed an initial increase of lysozyme activity followed by a decrease; a successive 30 R radiation showed a gradual decrease. Generally, large dose irradiation induced a decrease of serum lysozyme activity. In the partial body x irradiation of rabbits, five fractions of 500 R each on two days brought about an initial increase of lysozyme activity with a rise during the over-all time to the abdomen, an indefinite change to the head, and a rise after several days to the liver. Twenty-five fractions of 100 R each to the abdomen showed a slight change. Different responses of the enzyme were observed on irradiation of different parts of the body. In the cases of patients treated with cobalt 60, changes of lysozyme activity were within normal limits. Evaluations of lysozyme activity as an indicator of radiation damage were not very accurate. A slight protective effect of lysozyme against ionizing radiation was recognized by administration prior to irradiation. (auth)

500 COMPLICATIONS FOLLOWING RADIOTHERAPY FOR CARCINOMA OF THE CERVIX. Nagai, Seiji; Sakurada, Nobuyoshi (Tohoku Univ., Sendai). Sanfujinka No Jissai; 21: No. 4, 307-13(Apr 1972). (In Japanese).

Studies were made on the delayed complications following irradiation for carcinoma of the cervix. The more carcinoma of the cervix was advanced, the more the occurrence of ulcer and vaginal fistula in the urinary bladder and rectum appeared in the early stage. The occurrence of these complications varied with the quality of external irradiation. That is to say, the complications following Liniac irradiation occurred in the early stage in spite of small doses of external and intracavitary irradiation, as compared with those of depth irradiation of x rays. Although it has been considered till now that the delayed disturbance of the urinary bladder and rectum depended upon the condition of intracavitary irradiation, the fact doesn't always follow such an esti-

mation. It became evident that the complications varied with the quality of external irradiation and were seen in the early stage with increasing amounts of depth dose distribution in spite of small doses of intracavitary irradiation. (Japan)

501 RELATIVE HAZARDS TO RADIATION WORKERS IN VARIOUS CLASSES OF DIAGNOSTIC X-RAY PROCEDURES, WITH SPECIAL REFERENCE TO WARD AND THEATRE RADIOGRAPHY. Williamson, B. D. P. (National Radiation Lab., Christchurch, N. Z.); Paris, N. F.; Samsen, L. Australas, Radiol.; 16: No. 2, 198-208(Jun 1972).

A classification of diagnostic x-ray procedures according to degree of radiation hazard to the personnel is presented. It is based on an analysis of published radiation injury cases, on theoretical considerations, and on experience in routine radiation protection surveys. The classification is qualitative rather than rigorous and procedures are grouped and ranked according to the following basic protection situations: radiography with all staff excluded from the radiation area, radiography with staff in the radiation area, fluoroscopy, and dangerous obsolete techniques. A suggested code of practice for diagnostic x-ray work in wards and operating theatres is appended. (auth)

502 BLASTOMOGENIC EFFECT OF IONIZING RADIATION. Aleksandrov, S. N. Vop. Onkol.; 18: No. 7, 108-17(1972). (In Russian).

The various roles of ionizing radiation are reviewed for thyrotropic tumors and the functioning of the hypophysis, the etiology of late effects of radiation, radiation-induced cancer and bone changes, and the general subject of blastomogenesis. Both incorporated radiation sources and external ^{60}Co radiation are referred to. The effects on kidneys, autologous transfusion of bone marrow, and the behavior of tissues with different levels of physiologic regeneration are also topics of interest in this review. (45 references) (K.S.W.)

503 SIXTH INTERNATIONAL CONGRESS OF NEUROPATHOLOGY, PARIS, FRANCE, AUGUST 31, 1970. Paris; Masson (1970). 1184p. (In several languages). (CONF-700861).

Topics studied at the VI Congress on Neuropathology are presented. The effect of the environment on the nervous system is discussed in one of them; several papers are presented on knowledge acquired about the effects of radiations since the last congress. The biology and pathology of the glia (a subject not previously treated) were studied using various techniques, particularly those involving isotopes. Twelve papers are abstracted separately for NSA. (France)

For abstracts of individual papers see: 504–507, and 548–555.

504 NEUROPATHOLOGICAL EFFECTS OF PROTON BEAM IRRADIATION IN MAN. Nielsen, S. L.; Kjellberg, R. N.; Asbury, A. K.; Koehler, A. M. (Massachusetts General Hospital, Boston). pp 203-10 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

Six patients with gliomas and three with pituitary tumors subjected to proton irradiation who died between 5 and 28 months after radiotherapy are discussed. Microscopic examination demonstrated the existence of necrosis associated with the infarct. The microscopic lesions appear in three grades: the first grade consists of a reduction in the myelin staining, a thickening of the vessel walls, and a moderated endothelial hyperplasia; the second grade is characterized by a cellular loss accompanied by an astrocytic proliferation; the third grade consists of a total necrosis. (France)

505 DELAYED RADIATION LESIONS OF THE HUMAN SPINAL CORD. Jellinger, K.; Sturm, K. W. (Univ., Vienna). pp 255-62 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

This investigation concerns the results of autopsies carried out on 11 adult patients, who developed radiation myelopathies after x radiotherapeutic treatment of cervical tumors. The average doses (except in two cases) were greater than the tolerated dose. The early lesions were characterized by a demyelination with a reduction in the number of oligodendroglia. The lesions were of telangiectasias form and related to the lesions occurring afterwards. Lesions of the oligodendroglia, the vascular endothelium, and the blood-brain-barrier are probably the most important factors of this myelopathy. (France)

506 EXPERIMENTAL STUDY OF MODIFICATIONS PRODUCED IN THE BLOOD-BRAIN-BARRIER BY β RADIATION. Csanda, E.; Szikla, G.; Vedrenne, C. (Sainte-Anne Hospital, Paris). pp 271-2 of Sixth International Congress of Neuropathology. Paris; Masson (1970). (In French).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

Modifications of the blood-brain-barrier, due to β radiation, were studied in order to elucidate the mechanisms responsible for the vascular or edematous changes characterizing the periphery of the necroses produced by the intercerebral implantation of ^{90}Y grains in man. The extent of the modified blood-brain-barrier is directly dependent upon the level of radiation and decreases with time, disappearing after about 3 months. The changes in the hemoencephalic barrier do not coincide exactly with the edema zone. The therapeutic value of these observations is discussed. (France)

507 HISTOLOGICAL ANALYSIS OF EARLY AND DELAYED LESIONS BY INTRA-CEREBRAL IMPLANTATION OF A β EMITTING ISOTOPE, ^{90}Y, IN MAN. STUDY OF ELEVEN CASES. Vedrenne, C.; Csanda, E.; Fontaine, C.; Szikla, G. (Sainte-Anne Hospital, Paris). pp 275-6 of Sixth International Congress of Neuropathology. Paris; Masson (1970). (In French).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The localized destruction of the cerebral matter by the stereotaxic implantation of ^{90}Y is characterized by identical lesions in the white and gray matter; however the reactions triggered off by the same radiobiological process vary with the target substrate. In the gray matter, the lesions were essentially cellular. In the white matter, reactions involving the demyelinization of the edema are important; glial reactions occur simultaneously. (France)

508 REGRESSION OF PULMONARY METASTASES DURING RADIATION TO A HYPERNEPHROMA: IMMUNITY AND CANCER. DeGiorgi, L. S. (Medical Coll. of Virginia, Richmond). Cancer; 30: No. 4, 895-9(Oct 1972).

The case presented here appears to be unique because during a preoperative course of radiation therapy to the hypernephroma, the pulmonary metastases showed radiographic evidence of progressive, spontaneous clearing with complete disappearance during 4 weeks of treatment. A brief review of the literature regarding spontaneous regression of pulmonary metastasis is undertaken, with attention to endocrine and immunologic theories. (auth)

509 MICROSPECTROPHOTOMETRIC STUDY OF POST-IRRADIATION DYSPLASIA IN VAGINAL SMEARS. Meyer, Anthony A.; Okagaki, Takashi (Univ. of Minnesota, Minneapolis). Cancer; 30: No. 4, 964-71(Oct 1972).

Nuclear DNA content in the cells of post-irradiation dysplasia and benign irradiation effect in the vaginal smear was studied by Feulgen microspectrophotometry. All materials were obtained at random from patients with invasive squamous cell carcinoma of the uterine cervix treated with radiotherapy. In all five cases with benign irradiation effect without significant atypia (Class I smear), the nuclear DNA content in the epithelial cells was of typical unimodal diploid. In 11 cases of post-irradiation dysplasia (Class III R smear), nuclear DNA content was measured in 50 intentionally selected atypical cells (in one case 48 cells), 20 polymorphonuclear leukocytes, and 20 benign epithelial cells on each cytologic preparation. In a majority of the cases of post-irradiation dysplasia, the nuclear DNA content was distinctively polyploid ranging from tetraploid to 32-ploid, whereas three cases were unimodal diploid, and two cases aneuploid. It appears that polyploidization of the nuclei is the basic feature of post-irradiation dysplasia, possibly arising from normal epithelial cells following radiotherapy. Two cases of aneuploid post-irradiation dysplasia suggest either DNA aberration of early premalignant changes or possibly residual-recurrent cervical neoplasia. The clinical significance of polyploid and aneuploid post-irradiation dysplasia is to be studied further. (auth)

510 RADIATION THERAPY IN CARCINOMA OF THE VULVA. A REVIEW OF 53 PATIENTS. Helgason, Norman M.; Hass, A. Curtis; Latourette, Howard B. (University Hospitals, Iowa City, Iowa). Cancer; 30: No. 4, 997-1000(Oct 1972).

Fifty-three patients were treated with radiation therapy for carcinoma of the vulva. Twenty-four of these patients received primary radiation therapy, and the absolute 5-year survival for this group was 8.3% (2/24). Twenty patients were treated for post-surgical recurrence with an absolute 5-year survival of 20% (4/20). Surgery is considered the treatment of choice in this disease entity. However, radiation therapy may be indicated when localized cancer, either primary or recurrent, has extended beyond the limits of surgical resection; when distant metastases are present; when the patient's general condition precludes surgery, or when surgery is refused. A discussion is given of our experience in the treatment of carcinoma of the vulva and the problems encountered with the use of radiation therapy. (auth)

511 CLINICAL PICTURE AND TREATMENT OF EXTENSIVE β BURN CAUSED BY RADIATION OF AN ELECTRON ACCELERATOR. Revskoy, A. K.; Lirman, A. V.; Shevtsov, A. N.; Yakovlev, G. M.; Perveev, V. I. (Tomsk Medical Inst., USSR). Med. Radiol.; 17: No. 10, 57-63(Oct 1972). (In Russian).

A case is described of clinical observation over a patient with an extensive burn due to external β irradiation from an electron accelerator with a total area of 24% of the entire body affected. As a result of complex treatment with stimulating therapy and autodermoplastics there was obtained a good outcome with a complete healing of all burn wounds. (auth)

512 LOCALIZED ACNEIFORM ERUPTION FOLLOWING COBALT IRRADIATION. Stein, K. M.; Leyden, J. J.; Goldschmidt, H. (Univ. of Pennsylvania, Philadelphia). Brit. J. Dermatol.; 87: No. 3. 274-9(Sep 1972).

A woman aged 45 developed a severe dense eruption of open and closed comedones and follicular cysts, confined to the irradiated sites, 5 months following deep cobalt γ teletherapy for a mediastinal lesion. Histological study revealed typical open and closed comedones, ruptured follicular cysts with surrounding foreign body reaction, and features of steatocystoma. It is postulated that the severe acneiform eruption reflects the interaction of multiple acneigenic factors in which γ irradiation served to localize the response. (auth)

513 SOME POPULATION CHANGES IN ORAL ANAEROBIC MICROORGANISMS, STREPTOCOCCUS MUTANS AND YEASTS FOLLOWING IRRADIATION OF THE SALIVARY GLANDS. Llory, H.; Dammron, A.; Gloanni, M.; Frank, R. M. (Centre de Recherches Odontologiques, Strasbourg). Caries Res.; 6: No. 4, 298-311(1972).

Study of the streptococci, yeasts, and anaerobic flora rampant caries, following irradiation of the main salivary glands for carcinoma of the upper respiratory and digestive tract, showed an important increase in Streptococcus mutans in saliva and dental plaque. The yeasts were also increased, as well as Actinomyces. Veillonella were decreased whereas the anaerobic streptococci, Shaerophorus and Bacteroides melaninogenicus stayed relatively constant. In patients irradiated for carcinoma of the maxillary sinus, where the main salivary glands were outside the field of irradiation, the oral flora was normal 2 yrs after irradiation and no rampant caries developed. (auth)

514 FUNCTIONAL CONDITION OF THE LIVER IN RADIATION AND COMBINED THERAPY OF GASTRIC CARCINOMA. D'yakova, A. M.; Androsov, N. S.; Stefani, N. V.; Androsova, R. A.; Saenko, N. T. (Inst. of Medical Radiology, Kharkov). Med. Radiol.; 17: No. 10, 18-23(Oct 1972). (In Russian).

The authors used biochemical tests to study the dynamics of changes of the liver function in patients with gastric carcinoma in remote gamma therapy. Biochemical investigations were made prior to and 24 hrs after the first irradiation, then after irradiation in a dose of 1500 and 3000 rad and completion of the course of the combined therapy. With the increase of the dose of irradiation, there grew changes of the urine formation function and proteosynthetic function of the liver. The increase of the sorbitdehydrogenase in the serum testified to the presence of structural changes. The liver capacity for synthesis of cholesterol ethers was more stable; the excretory function remained. These regularities detected in preoperative radiation therapy were also observed after the course of combined therapy. (auth)

515 MORPHOLOGICAL CHANGES IN THE THYROID GLAND IN PATIENTS WITH THYREOTOXICOSIS AFTER TREATMENT WITH ^{131}I. Kolesnikova, G. S. (Inst. of Medical Radiology, Kharkov). Med. Radiol.; 17: No. 10, 23-30(Oct 1972). (In Russian).

Morphological changes in the thyroid gland in 15 patients suffering from thyrotoxicosis were studied. These patients were treated with ^{131}I. The author revealed dystrophic and sclerotic changes not associated with a therapeutic dose, technique of introduction or the time of histologic investigation. In greatly changed thyroid gland, the presence of expansive lymphoid accumulations with the formation of lymphoid folliculi was found, this probably having an indirect indication to the degree of autoimmune aggression in these patients. In three patients out of 15, malignant tumors were found in the changed thyroid gland and in three patients foci of adenomatosis and proliferation were found. (auth)

516 CONDITION OF IODINE METABOLISM IN GAMMA-THERAPY OF ONCOLOGICAL PATIENTS. Balybin, E. S.; Palinkashi, D. G. (Moscow Medical Inst.). Med. Radiol.; 17: No. 10, 30-3(Oct 1972). (In Russian).

The radiometric method was used to study iodine metabolism in 84 patients with different localization of malignant tumors prior to and after gamma therapy. Prior to radiation therapy in $\frac{1}{3}$ of these patients, iodine metabolism was disturbed; in 27% a drop of the level in the body of organic iodine was observed. Following gamma therapy in integral doses of about 5 to 10 M rad, the number of patients with an increased content of ^{131}I in the thyroid gland increased by 17%; the level of organic iodine in the body remaining the same. With an increase of radiation loads during gamma therapy up to 20 to 50 M rad, the number of oncological patients with a lowered level of organic iodine in the body increased by 18% as compared to the same contingent among non-irradiated patients. (auth)

517 DEUTSCHER ROENTGENKONGRESS 1971. REFERATE UEBER DIE 52. TAGUNG DER DEUTSCHEN ROENTGENGESELLSCHAFT. (German Roentgen Congress 1971. Abstracts from the 52nd Proceedings of the German Roentgen Society). Conference held at Duesseldorf, Germany, May 20-22, 1971. Fortschr. Geb. Roentgenstr. Nuklearmed., Beih.; 1-204 (1972). (CONF-710560-(Absts.)).

Summaries of 167 papers are presented. Fifteen papers describe congenital cardiac valve defects. Eleven papers describe acute abdominal disorders. Twnety-four papers deal with nonmalignant and malignant bone tumors. Three papers deal with contrast media. Radiation treatment of space-occupying lesions in brain and spinal cord is the subject of twelve papers. Electronic data evaluation is discussed in 20 papers. Fourteen papers are devoted to design, construction, and organization of modern radiation facilities for medical purposes. Eleven papers describe image intensifiers for radiography. Physics and technology are dealt with in eight papers. Nuclear medicine procedures are discussed in twenty papers. Eight papers describe methods for activation analysis. Twenty-one papers are devoted to various aspects of radiobiology. (H.G.B.)

Vertebrates

Refer also to abstracts 434 and 449.

518 (CONF-720941-1) IN VIVO LYMPHOCYTE TRANSFORMATION INDUCED BY H-2D AND H-2K COMPONENTS OF THE H-2 LOCUS. Popp, D. M. (Oak Ridge National Lab., Tenn.). [nd]. 14p. Dep. NTIS.

From fourth International Transplantation Society conference; San Francisco, CA. (24 Sep 1972).

Reports from several laboratories have shown that differential immune reactivity can be induced by different portions of the H-2 locus. By studying in vivo lymphocyte transformation induced by irradiated host antigens it has been possible to show that the cellular response to a non-H-2 antigen is delayed and qualitatively different from the response to H-2 antigens. In the present study, in vivo lymphocyte transformation was induced by incompatibilities at different portions of the H-2 locus in an attempt to learn more about the cellular basis of differential reactivity induced by different H-2 determinants. The immunogenetic effect of these incompatibilities was assessed by following the antigen-dependent proliferation of donor cells in the spleen of lethally irradiated mice. (auth)

519 (ORNL-4817, pp 110-29) MAMMALIAN GENETICS. Oct 1972.

In Biology Division annual progress report for period ending June 30, 1972.

Brief summaries of 22 projects in mammalian genetics are presented. Specific areas of research include: genetic effects of radiation in mice; mammalian cytogenetics and development; mammalian cytochemistry and mutagenesis; effects of radiation on mammalian gametogenesis; and comparative mutagenesis. (E.R.B.)

520 (ORNL-4817, pp 130-55) PATHOLOGY AND IMMUNOLOGY. Oct 1972.

In Biology Division annual progress report for period ending June 30, 1972.

Brief summaries of 44 projects in pathology and immunology are presented. Specific areas of research include: mammalian radiation recovery; radiation recovery of hematopoietic cells; experimental hematology; radiation immunology and senescence; hematopoietic regulation; cellular immunology; pathological effects of neutrons, high-energy radiation, and chemicals; hematology and radiation physiology; virology; animal virus research; histology and autoradiography; and mammalian radiobiology. (E.R.B.)

521 (ORNL-4817, pp 156-80) CARCINOGENESIS PROGRAM. Oct 1972.

In Biology Division annual progress report for period ending June 30, 1972.

Brief summaries of 47 projects in the carcinogenesis program are presented. Specific areas of research include: respiratory carcinogenesis; mechanisms of chemical carcinogenesis; mutagenicity of carcinogens; somatic cell genetics; repair mechanisms

in carcinogenesis; immunology of carcinogenesis; RNA tumor virus-cell biology; enzymology of carcinogenesis; regulation of gene expression; biochemistry of viral carcinogenesis; and RNA tumor virus-developmental processes. (E.R.B.)

522 (UCLA-12-886) EFFECTS OF RADIATION ON A FENCED POPULATION OF HORNED LIZARDS (PHRYNOSOMA PLATYRHINOS) IN SOUTHERN NEVADA. Medica, Philip A.; Turner, Frederick B.; Smith, Donald D. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). 1972. Contract AT-04-1-GEN-12. 21p. Dep. NTIS.

Between 1964 and 1966 minimum spring densities of horned lizards ranged from 1.0 to 2.5/ha in three 8-ha enclosures in Rock Valley, Nevada. Minimal survival of hatchling horned lizards to the age of 8 months was about 26 to 38%. Annual minimal survival of older lizards was 50 to 60%. Female horned lizards usually laid one clutch of eggs per year, but multiple clutches were observed in 1969. Conversely, no reproduction was observed in 1970. The maximum life span of horned lizards is at least 94 months. One of the enclosures was subjected to continuous gamma irradiation from a centrally located source of ^{137}Cs. Between 1964 and 1966 numbers of horned lizards declined in all three plots. Between 1967 and 1970 numbers of horned lizards increased in the two control areas, but continued to decline in the irradiated plot. Female sterility owing to regression of ovaries is judged to be the cause of the population decline. Similar radiation effects have previously been observed among leopard lizards (Crotaphytus wislizenii), whiptail lizards (Cnemidophorus tigris), and side-blotched lizards (Uta stansburiana). (auth)

523 HUMORAL IMMUNE RESPONSE IN MICE AFTER NEUTRON OR X IRRADIATION AT DIFFERENT DOSE RATES. Gottlieb, Charles F.; Gengozian, Nazareth (Oak Ridge Associated Universities, Tenn.). J. Immunol.; 109: No. 4, 711-18 (Oct 1972).

Acute radiation dose rate and radiation quality are two critical, although little studied, variables involved in nonspecific radiation immunosuppression. Mice ($C3BF_1$) were injected with sheep erythrocytes shortly after irradiation, and the humoral immune response measured over a 35-day period. With neutron irradiation, antibody formation was dependent only on the total dose, and not the dose rate. In contrast, the immune response after x irradiation was dependent on both the dose and dose rate. Maximum dose-rate differences occurred with 500 rads of x rays. Maximum depression with both neutron and x irradiation occurred when antigen was given 12 hr after exposure. The exposure-rate effect on immunocompetent cells was directly demonstrated at the cellular level by culturing irradiated spleen cells in lethally irradiated recipients. (auth)

524 RADIATION DOSE, DOSE RATE, AND QUALITY IN SUPPRESSION OF THE HUMORAL IMMUNE RESPONSE. Gottlieb, Charles F.; Gengozian, Nazareth (Oak Ridge Associated Universities, Tenn.). J. Immunol.; 109: No. 4, 719-27 (Oct 1972).

Radiation-induced immunosuppression was studied with special emphasis on the factors of dose rate and quality of the radiation. Fission neutrons, x rays, and ^{60}Co γ rays at dose rates ranging from 2.8 to 95 rads/min were tested for their biologic effect. Data reported earlier from our laboratory were supplemented as necessary to allow intercomparisons to be made. The biologic systems in the mouse included: (a) animal mortality, (b) immune response capability of the irradiated animal, and (c) antibody formation by irradiated spleen cells cultured in unresponsive hosts. The following empiric relationships were established: (a) the three biologic responses were each related to the radiation dose by a probit-type analysis, (b) the magnitude of the dose-rate effect was an exponential function of the linear energy transfer (LET), and (c) the inverse cube root dose-rate relationship reported earlier was confirmed. Immunosuppression of the whole animal was related to mortality, but not in a simple manner: as the LET of the radiation used declined, the level of immunosuppression at the LD_{50} increased, indicating that mortality is not necessarily a measure of the level of immune activity. We present an empiric expression relating the radiation dose rate and quality (LET) to the expected biologic effect, anticipating the possible application of these data to clinical situations. (auth)

525 CYTOCHEMICAL STUDY OF HISTONES IN LYMPHOCYTES OF RATS SUBJECTED TO X-RAY IRRADIATION. Manteifel, V. M.; Dolgorukova, N. I. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 6: No. 3, 243-7(1972). (In Russian).

Application of the reaction with alkaline-resisting green permitted determining the differences in histone distribution depending on the pycnotic stage of nuclear degeneration. In pycnotic nuclei with bright fluorescence of the complex of acridine orange with DNA, the histones remain in the nuclei; in dimly fluorescent pycnotic nuclei the histones are found only in cytoplasm. Localization of the histones in coarse nuclei is similar to chromatin distribution in them. (auth)

526 EFFECTS OF PERINATAL X-RAY IRRADIATION ON SUBSEQUENT DEVELOPMENT OF OVARIES IN RATS. Matsumoto, Akira (Tokyo Univ.). Annot. Zool. Jap.; 44: No. 2, 99-104(Jul 1971).

Ovaries of female rats irradiated with 190 R of x rays at 10 days of age remained undeveloped even after the animals reached the age of puberty. The ovaries were markedly reduced in weight, containing a good many small empty vesicles composed of cells with scanty cytoplasm, and nodular masses of small cells. Healthy-appearing follicles bearing ova were not encountered. In a majority of the animals, the vaginal smear records were characterized by either prolonged or persistent estrus. In females irradiated at day 18 of gestation or at birth, ovaries were approximately normal regarding both weight and histological structure. Estrus occurred cyclically in these animals. From these results, it seems probable that morphological and functional changes taking place in ovaries following x irradiation at 10 days of age were due to high radiosensitivity of oogonia and oocytes in their ovaries. (auth)

527 POSSIBLE ROLE OF GROWTH HORMONE IN THE STIMULATION OF THE THYMUS OF RATS FOLLOWING IRRADIATION OF THE HEAD. Maor, D.; Alexander, P. (Tel-Aviv Univ., Israel). Experientia; 28: No. 8, 957-9(15 Aug 1972).

Adrenalectomized rats were injected with epinephrine, serotonin, and growth hormone. The head only was exposed to 1000 R of 250 kV x rays and the rats were killed 48 hr later. Immediately after killing, the thymus glands were removed and weighed and the DNA was extracted and determined colorometrically. Results showed that both head irradiation and adrenalectomy lead to an increase in the rate of thymidine incorporation into the DNA of the thymus cells. It is suggested that head irradiation stimulates release of the growth hormone of the pituitary which stimulates the thymus. (H.L.W.)

528 PREVENTION OF TERATOGENIC AND EMBRYOCIDAL ACTION OF X RAYS BY LOW DOSES OF 5-HYDROXYTRYPTAMINE. Srebro, Z.; Bielen, E. (Inst. of Biomorphology, Krakow). Teratology; 5: 1-3(Feb 1972).

Pregnant rats were exposed to 200 R x irradiation on day 10 of pregnancy. 5-Hydroxytryptamine at a dose of 1 mg/kg body weight given subcutaneously 25 min prior to the irradiation showed significant antiteratogenic and antiembryocidal properties. A statistically significant increase in body weight was observed in near-term offspring of 5-HT-injected and x-irradiated females when compared with those only x-irradiated or untreated. (auth)

529 FORMATION AND REJOINING OF DNA STRAND BREAKS IN IRRADIATED NEURONS: IN VIVO. Wheeler, K. T.; Lett, J. T. (Colorado State Univ., Fort Collins). Radiat. Res.; 52: No. 1, 59-67(Oct 1972).

The rejoining of the strand breaks formed by x- and γ-irradiation of the DNA in the internal granular layer neurons of the canine cerebellum was followed in vivo at the level of the 165S chromosomal subunit. Single-strand breaks were produced with an efficiency of 58 ± 5 eV in the DNA of differentiated neurons, a value similar to that found for cultured dividing-cell lines, e.g., Chinese hamster ovary cells and murine leukemic lymphoblasts. The expression of the strand-break rejoining in neuronal DNA in vivo differed from that observed in dividing cells in vitro because reconstituted 165S subunits were degraded into smaller molecules during the early repair period. Large molecular weight species similar to those observed in unirradiated neutrons did not appear in significant quantities until 10 hr after irradiation. The exact mechanistic relationships of these events are not known at this time. (auth)

530 EFFECT OF WHOLE-BODY IRRADIATION ON THE METABOLISM OF 5-FLUOROURACIL-2-^{14}C IN THE RAT. Meeks, Marion J.; Kessler, Wayne V.; Arvesen, James N. (Purdue Univ., Lafayette, Ind.). Radiat. Res.; 52: No. 1, 82-7(Oct 1972).

The effect of whole-body irradiation on the metabolism of the anticancer drug 5-fluorouracil (FU) was determined in male rats by quantitating labeled urinary metabolites and $^{14}CO_2$ after the ^{14}C-labeled drug was administered. Treated animals received 445 to 461 R of ^{60}Co irradiation followed in 24 hr by an intraperitoneal injection of 50 mg FU/kg containing approximately 24 μCi. Control animals received labeled drug but no irradiation. During the 24-hr experiments animals were housed in controlled-ventilation glass metabolism cages from which $^{14}CO_2$ and urine samples were collected. Urinary metabolites were separated by thin-layer chromatography and quantitated by internal liquid scintillation counting. Irradiation produced an overall increase in the catabo-

lism of FU although the magnitude of this effect was small and is not likely to be of significant clinical importance. (auth)

531 EFFECT OF EXPOSURE RATE ON ANIMAL LETHALITY AND SPLEEN COLONY CELL SURVIVAL. Puro, E. A.; Clark, G. M. (Univ. of Toronto). Radiat. Res.; 52: No. 1, 115-29(Oct 1972).

In this study the response of mice to x-rays delivered at various exposure rates from 2.86 to 105 R/min was examined. Mouse lethality was observed over a 30-day period postirradiation. The $LD_{50/30}$ increased with decreasing exposure rate throughout the range studied with the greatest change occurring at lower exposure rates. Survival times and death distributions of the mice were analyzed and the results indicated that the time at which the mice died was independent of the exposure rate employed. The greatest mortality occurred between 9 and 30 days postexposure. From these results, bone marrow injury was interpreted as the primary cause of death of the mice at all exposure rates. The effect of exposure rate variation upon hematopoietic stem cell survival as estimated by the ability to form colonies (CFU) was studied. Cells obtained from the femoral marrows of mice were transplanted into irradiated recipient mice and subsequently irradiated within the recipients. The survival curves obtained were sigmoidal at the higher exposure rates, with a tendency for the curves to become more simply exponential as the exposure rate was decreased. Higher exposure rates were clearly more efficient in cell killing for dosages above 200 R. Below this exposure there was no measurable effect of exposure rate on cell survival. The radiosensitivity changes of endogenous CFU with exposure rate were substantially the same as for those obtained by the transplantation method. The results of the spleen colony experiments suggested a close association of CFU survival and animal lethality in the midlethal range. It was proposed that the exposure rate effect on animal $LD_{50/30}$ was explainable by the stem cell survival at that exposure. (auth)

532 THYMUS-INDEPENDENT (B) CELL PROLIFERATION IN SPLEEN CELL CULTURES OF MOUSE RADIATION CHIMERAS STIMULATED BY PHYTOHEMAGGLUTININ OR ALLOGENEIC CELLS. Piguet, P.-F.; Vassalli, P. (Univ., Geneva). J. Exp. Med.; 136: No. 4, 962-7(1 Oct 1972).

Spleen cell cultures of radiation chimeras (thymectomized, lethally irradiated mice repopulated with bone marrow cells and thymocytes bearing different chromosomal markers) were stimulated by phytohemagglutinin (PHA) and F_1 allogeneic spleen cells. Karyotypic analyses showed a marked predominance of T mitoses on the 2nd and 3rd days of culture followed by a strong predominance of B mitoses on the 4th and 5th days. Analysis of cells undergoing their first mitoses showed that the majority of T mitoses on day 3 resulted from continuous T cell division, and that most cells entering their first mitoses at that time were of B type. Mixed lymphocyte cultures (MLC) of chimeras immunized against allogeneic spleen cells showed sometimes, but not always, a response different from primary MLC, with an earlier and stronger predominance of BM mitoses. The role of stimulated T cells in the induction of B mitoses was shown by the incapacity of T-depleted spleen cells to be stimulated by PHA or in primary or secondary MLC, and the restoration of the mitotic response of B cells to PHA by adding to the T cell-depleted culture either a very small number of T cell (identified by their different karyotype: in vitro chimeras) or the cell-free supernatant of a 24 hr MLC. (auth)

533 FLUOROMICROSCOPIC STUDIES ON IRRADIATED ASCITES TUMOR CELLS. 2. RELATIONS BETWEEN IRRADIATED DOSES AND TIME INTERVALS. Sato, Mitsuo (Toho Univ., Tokyo). Toho Igakkai Zasshi; 18: No. 6, 874-81(Dec 1971). (In Japanese).

In the previous report, the acridine orange staining method was proved to be a useful tool in assessing radiation damages in cells. Using the method, the author observed the temporal change in fluorescence of Ehrlich ascites tumor cells that were irradiated with different doses (50, 250, 500, and 1000 R) of x rays. The number of abnormally fluorescent cells increased soon after irradiation reaching the maximum at 3 to 12 hrs. The maximum was then followed by a temporary decrease at about 18 hrs and another increase from 24 hrs onward. Also, the number of abnormally fluorescent cells was found to increase following the dose of radiation. The highest frequency of abnormal fluorescence was found in the nuclei, the least in the cytoplasm of irradiated tumor cells. Particular emphasis should be placed on the fact that the change in fluorescence of irradiated cells developed preceding any morphological change found through regular staining. The fluoromicroscopic method might be a useful tool for providing some indication regarding the effectiveness of radiation therapy against tumors. (auth)

534 EFFECTS OF IRRADIATION ON SPERMATOGENESIS IN THE GUPPY, LEBISTES RETICULATUS. Kobayashi, Jindo; Yamamoto, Toshiyuki (Tokushima Univ., Japan). Tokushima J. Exp. Med.; 18: 21-7(Oct 1971).

Quantitative studies on spermatogenesis in the guppy under normal conditions and after irradiation are reported. The sensitivities of each germ cell at different stages of development and their recovery after radiation injury were examined. After irradiation with 500 R, the cells at each stage gradually decreased. The spermatogonia were the most sensitive to irradiation followed by spermatocytes and spermatids. Spermatozoa were very resistant to irradiation. After irradiation with 1000 R, the decreases in the percentages of spermatogonia, spermatocytes, and spermatids were similar to those after irradiation with 500 R, but recovery was very slow. Two peaks were seen in the percentage of germ cells during recovery after irradiation with 500 R. The first peak may be due to delay in division of cells at each stage caused by irradiation and the second peak may be due to proliferation of new cells during the repair process. Spermatogonia were the most sensitive to irradiation followed by spermatocytes and spermatids. Spermatozoa were very resistant to irradiation. (Japan)

535 RADIATION PROTECTION BY ORAL ADMINISTRATION OF L-CYSTEINE ETHYL ESTER HYDROCHLORIDE IN MICE. Akaboshi, Sanya (National Inst. of Radiological Sciences, Chiba, Japan); Shikita, Mikio; Matsui, Eiichi; Hoshino, Hirosuke. Chem. Pharm. Bull. (Tokyo); 20: No. 4, 721-4(Apr 1972).

Cysteine ethyl ester hydrochloride was as effective as cysteine in saving the life of x-irradiated (600 R) mice, regardless of whether it was given orally or intraperitoneally. However, the compound did not prolong the life of the animals who received a higher dose (800 R) of x rays. Notwithstanding rather weak effectiveness in radiation protection, cysteine ethyl ester will be useful because of its low toxicity; median lethal oral dose in mice was 35.8 mmoles/kg, while the radioprotective effect was observable in an oral dose of 2.0 mmoles/kg. (auth)

536 EXPERIMENTAL STUDIES OF RENAL DAMAGE FOLLOWING IRRADIATION. Tanaka, Tsunahiro (Showa Univ., Tokyo). Showa Igakkai Zasshi; 31: No. 6, 304-14(Jun 1971). (In Japanese).

Renal damages were examined up to 3 months following irradiation administered to one kidney in a dose of 1000 R or 3000 R in dogs. Renograms and scintigrams as well as histological findings were evaluated in this experiment. Latex particles, several microns in diameter, were injected into the renal arteries and obliterations of the renal capillaries anywhere at the narrow point in caliber were observed. It was expected that blood supply decreased at this point and that radiation induced narrowing of the capillary owing to edema or fibrosis might be detectable. As to the results, though the detection of early renal damage was difficult, scintigrams provided some information of renal disturbance as early as several days after irradiation. Because of the progressive changes of the interstitium and of the capillary in sequential histological findings in relatively low dose level, the parenchymal damage might well be secondary to them. Therefore, we were of the opinion that the kidney was never a radioresistant organ in the treatment of patient. (auth)

537 STUDIES OF BONE LESIONS WITH ^{85}Sr. Yoshii, Hirobumi (Kumamoto Univ., Japan). Kumamoto Igakkai Zasshi; 45: No. 8, 851-6(25 Aug 1971). (In Japanese).

Examination of strontium-85 uptake of the bone was conducted following 4000 R and 6000 R telecobalt-60 irradiation over the femur of rabbits. Epiphysis was damageable and quick in recovery; diaphysis, however, was subject to serious damage and to very slow recovery. The 6000 R irradiation revealed extremely retarded recovery of the bone disturbance. Radioactive measurement as well as scanning of the bone was proved to be effective in the examination of the bone damage by irradiation. (auth)

538 HEMORRHAGIC SYNDROME DUE TO IRRADIATION IN THE RAT: PROTECTIVE AND PREVENTIVE ACTION OF SODIUM 2-PHENYL-5,7-DIOXYACETATE-BENZO-GAMMA-PYRONE. Mainieri, Luigi; Lampugnani, Paolo (Univ., Pavia, Italy). Clin. Ter.; 58: No. 1, 47-55(15 Jul 1971). (In Italian).

The antihemorrhagic action of sodium 2-phenyl-5,7-dioxyacetate-benzo-gamma-pyrone was studied in rats irradiated and treated simultaneously with or successively to the irradiation. A shortening of the hemorrhage time and a reduction of the hemorrhage intensity was observed in the treated animals in contrast to the non-treated rats. (tr-auth)

539 PROGRESSIVE INTERCAPILLARY GLOMERULOSCLEROSIS INDUCED BY WHOLE-BODY ^{60}Co γ IRRADI-

ATION IN THE MOUSE. Nakamura, Takaaki (Nagoya City Univ., Japan). Nagoya Med. J.; 17: No. 3, 223-9(Feb 1972).

Female CBA/H mice were used to study delayed radiation effects of ^{60}Co whole-body irradiation on the kidney. Total radiation dose was 1,100 R and it was fractionated into three doses. Animals were studied by light and electron microscope, using an immunofluorescent antibody technique 4 to 12 months after irradiation. Microscopically, glomerular lesions consisted of the lobulation and simplification of the tufts, the increase of the mesangial material, and the thickening of the capillary basement membrane. Submicroscopically, there were the fusion of the foot processes and the appearance of the electron-dense material in the subendothelial space and sometimes in the subepithelial space. The same dense material was also found in the mesangial region. The capillary basement membrane showed the thickening of the lamina densa and sometimes the splitting of its continuity. By the immunofluorescent antibody technique, the positive fluorescence of the mouse $\gamma_1 + \gamma_2$ globulins was found in the glomerular capillary wall and mesangial region. The present study would suggest that there is a possibility that irradiation induced intercapillary glomerulosclerosis is caused by an abnormal immunological state produced by the ^{60}Co irradiation. (auth)

540 ABSCOPAL X RADIATION EFFECT AND RECOVERY OF SPLENIC WEIGHTS OF MICE. Sato, Fumiaki; Muramatsu, Susumu; Nakamura, Wataru (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 11, 136-40(Feb 1971).

The weights of a group of mice that received 500 R x radiation to whole body began to recover at 9 days. On the other hand, the splenic weights of groups receiving 1000 R to the trunk with or without lower body exposure showed an earlier onset of recovery than that of 500 R to whole body. In order to observe an abscopal effect of irradiated lower body on the splenic weights, some groups of mice received graded doses to the lower body immediately after a 1000 R exposure to the trunk. In the groups of above combined exposures, changes of splenic weights were approximately independent of the doses to the lower body up to 7 days after irradiation. The doses to the lower body had some influence on the maximum recovery at 11 days after irradiation. The splenic weights at 11 days increased with the doses to the lower body up to 700 R. (auth)

541 INFLUENCE OF X IRRADIATION OF THE ADRENAL GLAND ON CORTICOID SECRETORY ACTIVITY IN DOGS. Nakasone, Keishun (Nagasaki Univ., Japan). Tohoku J. Exp. Med.; 106: No. 1, 83-7(Jan 1972).

Adrenocortical activity in the dog was studied during the first 4 hrs after x irradiation of the adrenal with doses of 200 to 2,000 R. Under anesthetized conditions, the secretory activity was determined by measuring 11-hydroxycorticosteroids in the adrenal venous blood. The adrenocortical activity was found to be stimulated by localized x irradiation of 800 to 2,000 R to the adrenal: the response being roughly proportional to the dose. However, with hypophysectomized dogs, the adrenocortical secretory response to x irradiation of the adrenal was entirely absent, probably as a result of hypophysectomy. These results suggest that the x irradiation doses of 800-2,000 R in the present study, if delivered directly to the adrenal, produce an augmentation in the corticoid secretory activity and its action occurs through the pituitary-adrenocortical mechanism. (auth)

542 EFFECT OF CARBON PARTICLES ON HEMATOLOGICAL RECOVERY IN IRRADIATED MICE. Nakamura, Sei-ichi (Prefectural Inst. of Public Health, Osaka). Radiat. Res.; 52: No. 1, 130-7(Oct 1972).

The effect of carbon particles on survival and hematological recovery of x-irradiated mice was studied. The administration of carbon particles, in the range of 5 to 15 mg per mouse, 24 hr before irradiation showed good protection against 600 R of x-rays. Similar protection was also observed in the mice which received 5 mg of the particles 3 hr after irradiation. The initial radiation-induced depression in splenic weight was partly prevented in the mice injected intravenously with 10 mg of carbon particles 24 hr before irradiation (500 R). The number of erythrocytes in the protected mice decreased similarly as observed in the irradiated control mice. But carbon particles promoted the subsequent early recovery in the number of erythrocytes. On the other hand, the number of erythrocytes in the unprotected mice was still decreasing. The effect of carbon particles on the decrease in the number of leukocytes was similar to that of erythrocytes except that the former showed a quicker recovery. As a possible explanation for the protective action of carbon particles, functional blockade of RES which clears the injured cells, and enhancement of the proliferation of leukocytes, is plausible. (auth)

543 INTERRELATIONSHIP OF ERYTHROPOIETIC RECOVERY, MARROW RECOVERY, COLONY-FORMING UNITS, AND ERYTHROPOIESIS-STIMULATING FACTORS AFTER SUBLETHAL X-IRRADIATION. Okunewick, James P.; Fulton, Doris; Markoe, Arnold M.; Phillips, Eleanore L. (Allegheny General Hospital, Pittsburgh). Contract AT(11-1)-3097. Radiat. Res.; 52: No. 1, 138-51(Oct 1972).

Studies have been performed to compare the injury and recovery of various elements of the erythropoietic system after sublethal (200 R) exposure to x-rays. In the peripheral blood a distinct fall and an early (6–7 day) abortive rise in reticulocytes and newly formed hemoglobin could be seen, followed by a second drop and final recovery to normal levels at 2–3 weeks after exposure. A similar drop in total nucleated cells could be seen in both femoral marrow and spleen. However, splenic recovery was slow, whereas recovery to normal nucleated cell levels occurred by 5 days in the marrow. Transplantable marrow colony-forming units also showed delayed recovery reaching normal proportions at 16 days with no abortive rise. Total blood and plasma volumes showed only minimal changes, although there was a significant drop in hematocrit. Levels of erythropoiesis-stimulating factors (ESF) showed a slight increase consistent with the fall in hematocrit but no large fluctuations which could be easily correlated with the variations in reticulocyte production. The data have been compared with other published data for postirradiation changes in the ESF-responsive compartment and some possible causes for the variations in postirradiation erythropoiesis are discussed. (auth)

544 FINE STRUCTURE OF INTESTINE AND LIVER IN IRRADIATED MICE DURING FAT ABSORPTION. Hampton, J. C.; Rosario, B. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 52: No. 1, 152-67(Oct 1972).

C57Br/cdj mice were exposed to 1500 R whole-body x irradiation and sacrificed 1, 2, 3, 3.5, and 4 days postirradiation. Thirty minutes prior to sacrifice each mouse received 0.2 ml of safflower oil-^{3}H-palmitic acid. Specimens of ileum, jejunum, and liver were examined with light and electron microscopes. Through 2 days postexposure, absorption and transport of lipid in both ileum and jejunum were essentially normal and liver glycogen and lipid content were stable. Beginning on day 3 ileal function began to fail rapidly but the jejunum functioned near normal. On day 3.5 jejunal absorption declined somewhat and hepatocytes were virtually depleted of glycogen and of intracellular lipid. Changes in absorption paralleled subcellular changes in epithelial cells, e.g., mitochondria were abnormal in appearance and reduced in number, ribosomes were depeleted and only remnants of endoplasmic reticulum and Golgi membranes remained. The cellular effects observed are in accord with the time of onset of inhibition of protein synthesis in epithelial cells exposed to x rays, suggesting that irradiated cells lost the ability to synthesize the protein necessary to maintain the intracellular enzyme systems required for normal metabolism and the exportable protein components of chylomicrons. Failure of protein synthesis is attributed to inhibition of ribonucleoprotein synthesis or of ribosomal assembly rather than a direct effect on existing ribosomes. (auth)

545 INTESTINAL CRYPT SURVIVAL: THE EFFECT OF ^{60}Co, 250 kVcp X RAYS AND FISSION NEUTRONS. Sigdestad, Curtis P. (Univ. of Louisville, Ky.); Scott, Ralph M.; Hagemann, Ronald F.; Darden, Edgar B. Jr. Radiat. Res.; 52: No. 1, 168-78(Oct 1972).

Intestinal crypt survival was studied using the method of Hagemann, Sigdestad and Lesher in mice irradiated with 250 kVcp x-rays, cobalt-60 and fission neutrons. The D_0's for the three treatment modalities were 377, 375, and 103 rads with extrapolation numbers of 6.2, 9.2, and 3.1, respectively. The RBE (ratio of D_0's relative to x-rays) was 3.6 and 1.0 for neutrons and cobalt-60, respectively. The $LD_{50(5)}$ values were found to be 1081 (945–1247), 1365 (1279–1456), and 252 (234–273) rads. The RBE [ratio of $LD_{50(5)}$ relative to x-rays] values were found to be 4.3 and 0.8 for neutrons and cobalt-60 irradiation. Intestinal crypt survival varied from 25 to 34% of control at all of the $LD_{50(5)}$ values. Total and per crypt cellularity was determined at 3 days postirradiation for each modality. The maximum proliferative response, measured at this time, occurred at or near the $LD_{50(5)}$ dose for each type of radiation. (auth)

546 LATE EFFECTS OF IONIZING RADIATIONS IN THE CHICKEN: SURVIVAL, BODY WEIGHT, AND PATHOLOGY. Stearner, S. Phyllis; Christian, Emily J. B. (Argonne National Lab., Ill.). Radiat. Res.; 52: No. 1, 179-96(Oct 1972).

White Leghorn roosters, 3 to 4 days after hatching, received single exposures to either ^{60}Co γ-rays or 200 kVp x-rays. Doses were in or immediately below the acute lethal range. Survivors at 35 days were caged individually and maintained for duration of life

observations (85 control and 193 irradiated birds). Survival time, weight, and major pathologic findings were determined in control and in four irradiated groups (A, 24-hr γ-ray exposure to 700 to 1000 R, 30-day lethality <3%; B, 24-hr γ-ray exposure to 1200 to 2000 R, 30-day lethality 10–80%; C, 6 to 60 min γ-ray exposure to 700 to 1100 R, 30-day lethality 10–80%; D, 30-min x-ray exposure to 1000 to 1200 R, accompanied by prophylactic treatments that reduced acute lethality from 99% to 30–80%). Mean survival time of controls was about 6 years and maximum life span was 10.6 years. A single γ-ray exposure in the acute lethal range (groups B and C) resulted in a mean life shortening of about 50%, and the decrease in body weight (growth) was correlated with decrease in mean survival time. When the exposure time was increased from 1 hr to 24 hr, radiation effectiveness for life-span shortening and for weight was reduced. In x-irradiated birds protected against acute lethality by various prophylactic treatments, there was a differential effect on survival and growth; growth was more severely reduced than would be expected on the basis of 30-day mortality or life-span shortening. The principal radiation-induced lesions were those characteristic of cardiac failure; these were observed most frequently in birds that died before 5 years of age. Tumors were commonly testicular in origin; they were found with equal frequency in irradiated and unirradiated groups. The incidence of leukosis, a virus-induced neoplasia, was reduced in irradiated groups and was zero after the higher radiation exposures (groups B and D). (auth)

547 CATABOLISM OF SERUM ALBUMIN IN X-IRRADIATED MICE. Sassen, A.; Kennes, F.; Reuter, A.; Telia, M. (CEN/SCK, Mol, Belgium). Radiat. Res.; 52: No. 1, 197-203(Oct 1972).

Determination of apparent half-life of ^{131}I screened mouse serum albumin was performed in x-irradiated mice. By comparison with control animals, a shorter half-life was observed in the plasma and in several tissues. On the contrary, no significant changes were obtained by whole body counting. This discrepancy was mainly due to diffusion and retention of labeled albumin in the gastric content. By comparison with a normal daily catabolism of 30 mg, 800 R of x-rays induced a degradation of about 37 mg. After 1500 R and chemical protection, about 40 mg of albumin was destroyed each day. (auth)

548 DELAYED REACTIONS IN THE BRAINS OF MONKEYS FOLLOWING RADIATION EXPOSURE. Haymaker, Webb (Ames Research Center, Moffett Field, Calif.). pp 211-27 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

Monkeys (Macaca mulatta) were totally and uniformly irradiated with 2 MeV x radiation and 55 MeV, 138 MeV, and 400 MeV protons. Various lesions were observed in the brains of these monkeys, the most frequent being vascular lesions (in particular development of telangiectasias and formation of aneurysms). The oligodendroglial cytoplasm presented accumulations of glycogen and exhibited necrosis phenomena. The astrocytes of the microglia cells become hypertrophic before the appearance of delayed lesions. (France)

549 HISTOCHEMICAL AND ULTRASTRUCTURAL EVENTS IN RADIATION INJURY OF THE BRAIN. Lierse, W.; Franke, H. D. pp 228-36 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The reaction occurring after irradiation begins with disturbances in the blood-brain-barrier, modifications of the glucide metabolism and the neuroendocrine functions of the hypothalamus and hypophysis. The capillary walls also are damaged leading to disturbances in the permeability. Cellular lesions are observed. An acute injury of the nerve cells is characterized by loss of proteins followed by the disappearance of cytoplasmic RNA, and finally by the disintegration of the nuclear DNA. After a delay (depending upon the dose time) a radionecrosis of the central nervous system is observed. (France)

550 CNS AXONAL DYSTROPHY FOLLOWING DELAYED X IRRADIATION IN MONKEYS. Roizin, L. (Columbia Univ., New York); Kaufman, M. A.; Liu, J. C.; Aksi, K.; Carsten, A. L. pp 237-46 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The brains of six monkeys were examined using electron microscopy after x irradiation. Myelopathic lesions were observed. These lesions were similar to those observed in axonal dystrophy with children or in vitamin E deficiency cases. Both these cases present similar spheroid or ovoid shapes in the deep gray matter layers, and in the subcortical white matter. (France)

551 EFFECTS OF X RAYS ON PROLIFERATION IN NERVOUS TISSUE. Cavanagh, J. B. (Medical Research Council, London). pp 263-4 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

Brains were wounded after they had been subjected to local irradiations varying between 200 and 2000 rads. The inhibition of the cellular proliferation is proportional to the radiation dose and simultaneously affects the astrocytes and the microglia cells. The oligodendrocytes are apparently unaffected as they do not respond to this type of injury by proliferation. It can be concluded that under normal circumstances, the astrocytes do not undergo many cell divisions; this is also true for the microglia cells. (France)

552 HYPERPLASIA AND BLASTOMA FORMATION OF INTRAUTERINE IRRADIATED MICE. Ostertag, B. pp 265-6 of Sixth International Congress of Neuropathology. Paris; Masson (1970). (In German).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

Mice were subjected to intrauterine x-radiation. A 180 R dose was delivered to gravid animals. Only part of the uterus was irradiated, resulting in only part of the embryo being irradiated, the rest remaining normal. The brains of 11 day old embryos exhibited a certain hyperplasia formed from cell aggregate rosettes capable of proliferating and giving rise to masses of hypertrophied nervous tissue. Blastoma type hyperplasia can also be observed. (France)

553 ELECTRON MICROSCOPY STUDY ON SYNAPSES IN X-IRRADIATED CNS. de Estable-Puig, R. F.; Estable-Puig, J. F. (Univ. Laval, Quebec). pp 267-8 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The heads of rats were exposed to 20,000 Roentgen of x radiation. Samples taken 24 or 72 hours after irradiation demonstrate the existence of a very marked pyknosis of the neuron nuclei; these modifications were very intense in the granule cells of the olfactory bulb and cerebellar cortex. The neurons were damaged along their entire axonal and dendritic arborizations. The terminal ramifications of the neurons and the synapses were also abnormal. (France)

554 EFFECT OF DOSE FRACTIONATION ON DELAYED RADIATION ENCEPHALOPATHY. Mastri, A. R.; Chu Chang (Columbia Univ., New York). pp 269-70 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The effect of irradiation (^{60}Co source) on the brains of two groups of cats was studied, the dose and the dose rate being considered. The first group of 20 cats received a single dose of 2400 rads; they exhibited radionecrosis damage (particularly in the white matter) as well as fibrosis damage and a certain amount of telangiectasis. The second groups of cats was subjected to a fractionated irradiation; these presented a cerebral necrosis with a fibrous transformation of the blood vessel walls in the white matter. (France)

555 DELAYED NECROSIS IN THE LIMBIC LOBE OF THE RAT BRAIN FOLLOWING LIMITED-HEAD X IRRADIATION. Brownson, R. H.; Ingersoll, E. H.; Carsten, A. L. (Univ. of California, Davis). pp 273-4 of Sixth International Congress of Neuropathology. Paris; Masson (1970).

From sixth international congress of neuropathology; Paris, France (31 Aug 1970). See CONF-700861.

The heads of male rats were irradiated with a single localized 5000 rad dose, and the rats were sacrificed 12 months afterwards. All the irradiated brains exhibited bilateral lesions of the middiencephalon, in particular in the white matter. Astrocytes and macrophages infiltrated the necrotic areas. The neuron cell bodies underwent necrosis. The granular cells were at different stages of degeneration. The blood vessels showed marked wall thickening. (France)

556 CHANGES IN STELLATE GANGLION NERVOUS STRUCTURE EVOKED BY TOTAL X-RAY IRRADIATION. Demidova, G. G. (Inst. of Genetical Microbiology and Virology, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 5, 457-61 (1972). (In Russian).

Dystrophic and destructive changes in the stellate ganglion nervous structure were mainly found in radiopathology dynamics during whole-body x irradiation of rabbits (a dose of 1400 R). Besides, essential compensatory-reduction processes were exposed. But destructive changes are prevailing, that results in death of nerve cells. (auth)

557 METABOLISM OF NAD AFTER WHOLE-BODY IRRADIATION. 4. INCORPORATION OF NICOTINAMIDE BY ISOLATED PERFUSED LIVER AND BY INTACT RATS. Gerber, G. B.; Deroo, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Int. J. Radiat. Biol.; 22: No. 4, 351-60(Oct 1972).

The metabolism of nicotinamide was investigated in organs of normal and x-irradiated intact rats (24 hr after 1000 R whole-body irradiation) and in isolated perfused rat liver. Rates of reactions were calculated from the data on liver perfusion. At low substrate levels, incorporation of nicotinamide seemed to involve pathways via nicotinamide mononucleotide, whereas at high substrate levels the Preiss–Handler pathway via nicotinic acid could play a role. The changes after irradiation are explained as the result of an increased catabolism of NAD that cannot be entirely compensated for by re-synthesis. (auth)

558 RADIATION LEUKEMIA IN GUINEA PIGS. Van Pelt, A.; Congdon, C. C. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 52: No. 1, 68-81(Oct 1972).

Forty-eight cases of leukemia were identified in 629 control and irradiated guinea pigs observed at the National Cancer Institute during the years 1947 through 1960. Twenty-eight of the cases were lymphatic and 20 were stem cell leukemia. Statistical evidence for radiation induction of lymphatic and stem cell leukemia was found for special conditions of limited, chronic gamma-ray exposure. Stem cell leukemia was seen only in irradiated animals. In eight of the cases, including both types of leukemia, transplantation of the disease to normal syngeneic pigs was demonstrated. Unusual reactive changes in lymphatic tissues were seen at autopsy in five animals with stem cell leukemia. The pathology findings suggest that lymphatic leukemia originates in lymph nodes and stem cell leukemia in the bone marrow. (auth)

559 INCREASED IMMUNOGENICITY OF EHRLICH ASCITES CELLS AFTER HEAT TREATMENT. Mondovi, Bruno; Santoro, Antorio Scioscia; Strom, Roberto; Faiola, Rita; Fanelli, Alessandro Rossi (Univ., Rome). Cancer; 30: No. 4, 885-8(Oct 1972).

Immunization of Swiss mice with Ehrlich ascites cells that were exposed in vitro to 42.5C for 3 hrs is more effective, so far as subsequent tumor transplantation is concerned, than immunization with radiation-inactivated cells or with cells exposed to 42.5C for 6 hrs. These results, which indicate that upon moderate heat treatment there is a definite increase of the immunogenicity of these cells, may have some relevance as to the mechanism of the delayed tumor regression that is often clinically observed after hyperthermic perfusion. (auth)

560 RADIATION-INDUCED LIFE SHORTENING IN GERM-FREE MICE. Anderson, R. E.; Scaletti, J. V.; Howarth, J. L. (Univ. of New Mexico, Albuquerque). Exp. Gerontol.; 7: No. 5, 289-301(Oct 1972).

The life span, prevalence of disease, and a variety of aging parameters were evaluated in 358 conventional and germfree virgin female mice of the CD-1 line, some of which were exposed to 700 R cobalt-60 γ radiation at 6 weeks of age. In comparison with the conventional groups, the exposed and nonexposed germfree animals showed a reduction in life span accentuated by irradiation, a reduced prevalence but accelerated appearance-rate of benign and malignant tumors, an increased incidence of amyloidosis, and displacement of a series of aging parameters consistent with accelerated aging. These observations are tentatively attributed to the characteristic hyporeactivity of lymphoreticular structures associated with the germfree state and particularly the attendant decrease in the pool of thymic-dependent recirculating small lymphocytes. (auth)

561 EFFECT OF THYMECTOMY, THYMECTOMY AND X IRRADIATION, AND X IRRADIATION ALONE ON EXPERIMENTALLY INDUCED TUBERCULOSIS IN THE CHICKEN. Panigrahi, D.; Fauser, I. S.; Mallmann, V. H.; Waxler, G. L. (Michigan State Univ., East Lansing). Amer. J. Vet. Res.; 33: No. 9, 1857-65(Sep 1972).

White Leghorn chickens that were thymectomized (Tx), thymectomized-x-irradiated (Tx-X), x-irradiated (X), and nontreated (control) were inoculated at 10 weeks of age with a viable culture of Mycobacterium avium. Ten weeks later, tuberculin reactions were evident in almost all of the exposed chickens 48 hs after tuberculin was injected. Although individual chickens reacted with different intensity, detectable difference did not exist among groups. Indirect evidence indicated that the reactions were, in part, due to an Arthus reaction. In thymectomized and thymectomized-x-irradiated chickens, there was varying lymphocytic depletion from the spleen. All groups of chickens inoculated with M. avium had granulomas in the liver, spleen, ileocecal junction, thymus, and lung. Although there was no essential difference in the cellular composition of these lesions, caseation necrosis was less prominent and caseous lesions were fewer in the hepatic sections of thymectomized and thymectomized-x-irradiated chickens; the lesions at the sites of inoculation were smaller in size. The results provided evidence that thymectomy significantly reduced tissue necrosis in tuberculous granulomas. (auth)

562 EFFECT OF CONTINUOUS LOW LEVEL IRRADIATION UPON HEMOGLOBIN BIOSYNTHESIS IN MICE. Rasad, Asri. (Univ. of Tennessee, Memphis). 93p. University Microfilms Order No. 72-24,658.

Thesis.

The C57BL mouse provides a model system for the study of hemoglobin biosynthesis concomitant with the erythroid cell development. In the adult mouse, the principal sites of hematopoiesis are the bone marrow and spleen. Hemolysates prepared from the peripheral blood, bone marrow, and spleen of adult male C57BL/Cum mice show a single electrophoretic hemoglobin band. In seeking to determine the effect of continuous low level irradiation upon the hemoglobin biosynthesis, adult male C57BL/Cum mice, age 50 or 120 days, were exposed to irradiation at 1.6 R per hour for 21 hours per day. Hemoglobin from peripheral blood, bone marrow, spleen, and liver was fractionated by vertical starch gel electrophoresis using Tris-EDTA-Boric acid buffer, pH 8.6. In the young adult male mice, age 50 days at the time of initial exposure, a fast-moving hemoglobin band appeared first in the liver after the mice were exposed to 1120 R, next in the spleen after 1640 R, then in the marrow after 1900 R with only a trace amount in blood. In the older mice, age 120 days at the onset of exposure, the hemoglobin was examined after exposure of 2100 R, 3000 R, and 3550 R. The fast-moving hemoglobin was first seen in the liver hemolysate after exposure to 2100 R, next in the spleen after 3000 R, then in the bone marrow in trace amounts after 3550 R. A fast-moving hemoglobin in addition to the normal adult hemoglobin was also found in the liver hemolysate of the fetus at 17 to 18 days of gestation and in the liver hemolysate of the pregnant mother. At time of delivery the fast hemoglobin was found in the liver and spleen hemolysates of the newborn with a trace amount in peripheral blood. The fast hemoglobin gradually decreased with the increase of adult hemoglobin and by 6 days after birth only adult hemoglobin was present. The fast-moving hemoglobin was called fetal hemoglobin, since it appears after the loss of embryonic hemoglobin and disappears after birth. Following incubation of the newborn liver, spleen, and peripheral blood with ^{14}C-labeled amino acids, the adult and fetal hemoglobins were radioactive indicating de novo synthesis of the hemoglobins by these tissues. Chain separation by carboxymethylcellulose column chromatography of the globin prepared from the newborn peripheral blood hemolysate showed the presence of a new chain in addition to the normal α and β chains. This new chain was called f chain following the nomenclature of P. A. Marks for embryonic hemoglobins with x, y, and z chains. The f chain was found when globin prepared from the newborn blood and liver hemolysates was subjected to chain separation by cellulose acetate membrane electrophoresis using 6 M urea – 0.05 M 2-mercaptoethanol buffer, pH 8.9. The finding of the fetal hemoglobin in the normal C57BL/Cum mouse parallels human fetal hemoglobin in its relationship to embryonic and adult hemoglobin. The finding of the fast hemoglobin in the liver, spleen, and bone marrow of the irradiated mice suggest that continuous low level irradiation has a tissue environmental effect that reverses the temporal development of hemoglobin synthesis and erythroid cells. (Diss. Abstr. Int., B)

563 CHANGES OF THE ABSORPTION PROCESS IN IRRADIATED RATS. Krichkovskaya, L. V.; Piskareva, E. V.; Busygina, N. A. (Inst. of Medical Radiology, Kharkov). Med. Radiol.; 17: No. 10, 39-44(Oct 1972). (In Russian).

Excitation of both the parasympathetic and sympathetic nervous system prior to irradiation with x rays in doses of 600 and 300 rad brought about a decrease of lethality and some normalization of the process of water absorption in the loop of the small intestine of rats. Inclusion of both parasympathetic and sympathetic nervous system prior to irradiation along with the increase of lethality caused more profound changes in the process of absorption. With a more severe form of the disease, water absorption was found to be intensified at all periods. With a milder course, normalization had occurred by the 50th day. The gravest changes took place under the effect of 3.8 MeV electron irradiation (600 rad). (auth)

564 PHYSICO-CHEMICAL CHANGES OF THE JOINT CARTILAGE AFTER IRRADIATION. Modyaev, V. P.; Podgornaya, V. L.; Karpova, N. A. (Inst. of Medical Radiology, Kharkov). Med. Radiol.; 17: No. 10, 44-9(Oct 1972). (In Russian).

Data are presented on the changes of acid mucopolysaccharides of the main substance and polarization-optic properties of collagenic fibers in different regions of the joint cartilage of mature rabbits at different periods after a single gamma irradiation (900 and 2000 rad). Histochemical studies of acid mucopolysaccharides and polarization microscopy are recommended as perspective methods for early diagnosis and prognostication of outcomes of radiation-induced affections of the tissue. (auth)

565 EFFECTS OF X RAYS ON THE ACTIVITY AND SYNTHESIS OF CATALASE IN MOUSE KIDNEY. Stefan, Maria. Rev. Roum. Physiol.; 9: No. 3, 247-50(1972). (In Rumanian).

Changes occurring in the catalase activity of the renal cortex of mice following administration of a single dose of 500 R x radiation were studied. The influence of ionizing radiation on the synthesis of the enzyme and the radioprotective effects of glycine on its activity and synthesis were also investigated. The results suggest that the reduced activity of catalase after exposure to x rays is due, at least in part, to their inhibitory effect on the synthesis of the enzyme. (tr-auth)

Invertebrates

Refer also to abstract 293.

566 (CONF-720650-1) SIMPLE METHOD OF MASS PRODUCTION OF FASCIOLA HEPATICA MIRACIDIA. Gomes, P.; Velarde, A.; de Leon, D.; Chiriboga, J. (Puerto Rico Nuclear Center, Mayaguez). [nd]. 2p. Dep. NTIS.

From American association of veterinary parasitologists convention; Athens, GA. (18 Jun 1972).

A technique is described for producing large numbers of miracidia from eggs of the sheep liver fluke as a part of a study on the effects of irradiated metacercariae on immune reactions in rats. The eggs are obtained at the slaughterhouse from the gall bladder of cattle with fascioliasis. It was found that the miracidia from the treated eggs had 100% ability to penetrate the snail, Lymnaea cubensis. (H.L.W.)

567 SOME EFFECTS OF IRRADIATION ON THEILERIA PARVA IN THE SALIVARY GLANDS OF THE TICK RHIPICEPHALUS APPENDICULATUS. Purnell, R. E.; Ledger, M. A.; Obatre, J. B. (East African Veterinary Research Organization, Muguga, Kenya). Parasitology; 65: No. 1, 23-6(Aug 1972).

Groups of R. appendiculatus ticks infected with T. parva were irradiated at doses varying from 0 to 32 krad and then applied to rabbits; 3 and 4 days later their salivary glands were removed, processed and examined. Increasing doses of irradiation resulted both in a decreased infection rate of ticks and a decrease in the number of parasite masses observed in infected ticks. No normal parasite masses were seen after doses of 4 krad or above. (UK)

568 RADIOSENSITIVITY OF OOCYTES OF DROSOPHILA. 3. SENSITIVITY OF CLASS-B OOCYTES OF XX/O AND X/X FEMALES. Wuergler, F. E.; Leuthold, U.; Graf, U.; Ulrich, H. (Swiss Federal Inst. of Tech., Zurich). Int. J. Radiat. Biol.; 22: No. 4, 367-77(Oct 1972).

It is pointed out that class-B oocytes of XX/O and X/X females of Drosophila melanogaster are equally radiosensitive. On the hypothesis that radiation-induced lethality in oocytes results from chromosomal damage in the oocyte nucleus, it would be expected that after x irradiation of XX/O females, more lethality would be observed in the progeny with a maternal XX/II/III/IV chromosome complement than in the progeny with a maternal II/III/IV complement. This was not found for the class-B oocytes of XX/O females, in contrast to the results of comparable experiments with class-A oocytes of the same type of female. It is concluded that radiation-induced lethality observed after treatment of class-B oocytes over a range 0 to 6 Krad results to a large extent from lethal damage induced in targets other than the chromosomes of the oocyte nucleus. (auth)

569 EFFECTS OF 5-BROMODEOXYURIDINE ON THE SILKWORM, WITH SPECIAL REFERENCE TO STAGE DIFFERENCES DURING THE FIRST INSTAR. Nakajima, Makoto (Tokyo Univ.). Nippon Oyo Dobutsu Konchu Gakkai-Shi; 15: No. 4, 189-97(Dec 1971). (In Japanese).

The effects of 5-bromodeoxyuridine (BUdR) and 5-bromouracil (BU) on growth, viability, and induction of aberrant spots in the silkworm, Bombyx mori, were compared at different stages during the first instar. The strongest effect was observed when the mutagen was administered on the second day, at the middle of the instar, showing the lowest viability and highest mutability. At the last instar, the mean size of the spots induced by feeding on the first day was about twice as large as those treated on the third day. By estimating the bromine contents 14 hrs after treatment, it was proved that the rate of BUdR or BU uptake on the second or third day was higher than that the first day, and that the rate of BUdR uptake was several times higher than that of BU uptake in each period. This could be one of the reasons why treatment on the second day was more effective than that of the first day on inducing aberrant spots and larval death. The synergistic effect of γ rays and BUdR on the production of aberrant spots was noticed when larvae were irradiated with γ rays (800 R) prior to the BUdR treatment on the first or third day, and also when larvae were irradiated after the BUdR treatment on the second day. It was suggested that these damages were due to the fact that the base analogues formed an integral part of the DNA structure. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 491, 498, and 502.

570 SWEDISH PILOT STUDY ON LUNG CANCER AMONG MINERS. Sundell, Lennart; Axelson, Olav; Rehn, Magnus; Josefson, Helge. Laekartidningen; 68: No. 49, 5687-93(1 Dec 1971). (In Swedish).

Occurrence of radon and radon daughters has been observed not only in uranium mines but also in other mines, both in Sweden and abroad. Increased mortality among miners working in uranium-containing mines has also been well established, and cases were reported also for mines not containing uranium. Deaths due to lung tumors were encountered among miners in the Narke zinc mine, where during 1969 to 70 the radon daughter activity was found to reach 30 to 100 pCi/l. The lung tumors usually develop after an exposure of at least 25 years. A 13-fold increase of the mortality due to lung cancer was noticed among miners in an active age; the mortality of other workers in the county was found to be normal. It was concluded that carcinogenic agents must be present in the mine. The presence of radon and its daughters was considered the primary factor but other etiological factors, such as carcinogenic metals in the mine dust must be also taken into consideration. Current experience with various preventive measures yielded favorable results but additional cytological techniques must be considered. (TTT)

571 STUDIES ON THE HEMATOLOGICAL CHANGES AFTER ADMINISTRATION OF THERAPEUTIC DOSES OF RADIOACTIVE IODINE. 1. STATISTICAL STUDIES ON THE OCCURRENCE OF LEUKEMIA. Nakayama, Shiro (Kyoto Univ.). Nippon Ketsueki Gakkai Zasshi; 33: No. 5, 560-77 (Oct 1970). (In Japanese).

Two cases of acute leukemia were found among a total of 3666 patients with hyperthyroidism who were previously treated with ^{131}I and followed up to 1965. This observed number of leukemia cases is higher than 0.4 cases that could be expected to occur fortuitously during the 5.0 yrs of mean observation period among the Japanese population that was matched by age and sex to the study group. However, the numbers involved are too small to assume statistical significance. So far, a total of 42 cases of leukemias following ^{131}I treatment were reported in domestic and foreign literature including newly detected cases of our series. The mean blood radiation doses of β and γ rays from ^{131}I were calculated as 22.43 ± 20.5 rads in hyperthyroidism and 945 rads in thyroid cancer, respectively. The bone marrow radiation doses were approximately 80% of the blood doses. It was noteworthy in these leukemia cases that acute myelogenous and aleukemic forms occurred significantly in higher proportions than in leukemia in the general public, and the latent period from the first administration of ^{131}I to the onset of leukemia ranged between 2 to 5 yrs in most of the cases. Although an increase of incidence of leukemia following the therapy of hyperthyroidism with ^{131}I has not been verified yet, all of the findings are strongly suggestive of a close relation between ^{131}I therapy and eventual development of leukemia. (auth)

572 PRIMARY CANCER OF THE LIVER FOLLOWING TREATMENT OF POLYCYTHAEMIA VERA WITH RADIOACTIVE PHOSPHORUS. Chudecki, B. (Royal Devon and Exeter Hospital, Eng.). Brit. J. Radiol.; 45: No. 538, 770-4(Oct 1972).

A summarized case history is presented for a primary cancer of the liver, following treatment of polycythaemia vera in a 60 year old white married woman. Four doses of ^{32}P 6mCi were given intravenously and after a period of 7.5 year, during which the polycythemia was well controlled, primary cancer of the liver was diagnosed. The chances of it being a radiation cancer are discussed, taking into account the 1969 annual incidence of primary liver cancer and polycythemia vera in the S. W. Region of the British Isles (pop 3,115,500), and the fact that the patient had been

diabetic for 4 years before diagnosis of the cancer, controlled with daily doses of 250 mg chlorpropamide. (UK)

573 CHROMOSOME ABERRATIONS IN URANIUM MINERS OCCUPATIONALLY EXPOSED TO ^{222}Rn. Brandom, William F.; Saccomanno, Geno; Archer, Victor E.; Archer, Philip G.; Coors, Marilyn E. (Univ. of Denver). Radiat. Res.; 52: No. 1, 204-15(Oct 1972).

Cultures of peripheral blood leukocytes were examined from 15 uranium miners occupationally exposed to long-lived ^{222}radon daughters and 15 normal age-matched, nonminer male controls. Mining experience was from 1 to 28 years and estimated cumulative exposure was from 10 to 5400 work level months. Hyperdiploid cells occurred with twice the frequency of uranium miners compared to control cells (2.13 vs. 1.60%). Cells with chromatid gaps, chromatid breaks and isochromatid gaps (B cells) also occurred with twice the frequency in uranium miner cells compared with control cells (12.9 vs 6.43%). The prevalence of stable cell aberrations such as abnormal monocentrics, deletions, and translocations was 0.0% in the controls and 0.13% in the miners. A documented indicator of radiation-induced chromosome aberration is the unstable cell aberration grouping. Dicentrics, rings, acentric fragments, and isochromatid breaks occurred at a frequency of 0.21% in the controls and 2.58% in the miners. All of the miners had cells with one or more of the unstable cell aberrations but cells of only three of the controls had this classification of chromosomal change and all of these were of the acentric fragment type. The differences between miners and controls in the prevalence of lymphocyte chromosome aberrations are statistically significant as well as of a magnitude that could be of biological importance. The findings are consistent with the conclusion that nonpulmonary cells of the miners undergo mutational changes as a consequence of exposure to radiation encountered in uranium mines. (auth)

574 LUNG CARCINOMA IN ORE MINERS IN THE NORTHERN BOHEMIAN REGION. Pekarek, V.; Martinec, M.; Urbanec, J. (Regional Hygienic Station, Usti nad Labem, Czech.). Prac. Lek.; 22: No. 5, 161-9(Jun 1970). (In Czech).

The geological composition of three ore mines in Northern Bohemia and working conditions in the mines are described. In the mines where the average number of miners who work underground is 265, 11 cases of lung carcinoma were recorded. Nine cases were recorded in wolfram, lithium and tin mines where the average radon concentration amounts to 400 pCi/1, two cases occurred in calcium difluoride mines where radon concentrations amount to about 100 pCi/1. On the basis of the time of exposure and the estimated average concentration of radon and its short-lived decay products in the mine, the rough estimation of a cumulative radiation dose to the bronchial epithelium was made for each miner suffering from lung carcinoma; the estimated doses of α-radiation varied between 2125 and 15,375 rem. The average exposure time of the patients was 14.09 years, the average age of miners in whom the tumour of the lungs was diagnosed was 53 years. The measurement of radon concentration in all mines was recommended, in order to reduce radon concentrations below the permissible limit by a forced ventilation where necessary. (NSA of Czech.)

Animals

Refer also to abstracts 581 and 588.

575 (COO-119-246, pp 272-81) TOXICITY TO BLOOD CELLS OF ^{241}Am COMPARED TO OTHER TRANSURANIUM NUCLIDES. Dougherty, Jean H. 31 Mar 1972.

In Research in radiobiology.

A comparison of the effects of the bone surface seekers ^{239}Pu, ^{241}Am and ^{228}Th and the bone volume seeker ^{226}Ra on leukocytes has been made for the first year following injection using the technic of probit analysis. Hematological responses for total white blood cells, polymorphonuclear leukocytes, lymphocytes and monocytes were evaluated at six time periods from 30 to 360 days post-injection. The probit of the percentage depression of the various cells when plotted against the log of the injected activity yielded approximately straight lines from which ED 50s (50% depression of leukocytes) were calculated. Using ^{226}Ra as a standard nuclide, toxicity indices (^{226}Ra μCi per kg/nuclide μCi per kg for 50% depression) were determined. From these data the hematological RBEs (^{226}Ra rads per day/nuclide rads per day for 50% depression) were computed for the various leukocytes over the first year. The surface seekers, ^{239}Pu, ^{241}Am and ^{228}Th showed considerably greater toxicity than ^{226}Ra. The pattern of depression and recovery of leukocytes is most similar for ^{241}Am and ^{239}Pu as shown by the probit method. (auth)

576 (COO-119-246, pp 282-3) BONE SARCOMA INDUCTION IN THE ST. BERNARD, A PILOT STUDY IN DOGS OF HIGH NATURAL INCIDENCE. Taylor, G. N.; Mays, C. W. 31 Mar 1972.

In Research in radiobiology.

Because of their high spontaneous incidence of bone cancer, young adult St. Bernards were given a single intravenous injection of ^{239}Pu. The appearance time of radiation-induced osteosarcomas in this giant breed was approximately $\frac{1}{2}$ of that observed in beagles when both were injected with 0.3 μCi ^{239}Pu/kg of body weight. (auth)

Plants

577 PINOCYTOSIS IN ROOT CAP CELLS EXPOSED TO URANYL SALTS. Wheeler, H.; Baker, B. L.; Hanchey, P. (Univ. of Kentucky, Lexington). Amer. J. Bot.; 59: No. 8, 858-68(Sep 1972).

In cap cells of intact plant roots exposed to 1mM uranyl for 30 min or less, uranyl crystals were found only in cell walls in secretory products which had been extruded from the protoplast. In roots exposed for 10-20 hr to 0.1mM uranyl, packets of uranyl crystals bound to secretory products were found within the protoplasts of those exterior cells which contained accumulations of secretory products between the cell wall and protoplast. Although the evidence indicated that these packets of crystals entered the protoplast pinocytotically, results with these specialized exterior cells did not apply to the vast majority of root cap cells in which, after prolonged exposure to 0.1mM uranyl, crystals were concentrated in vacuoles. In roots exposed to 1 or 5mM uranyl for 1 hr, the plasmalemma of interior cap cells was much thicker (13.1 nm) than normal (8.2 nm), and many invaginations and vesicular structures were found near the protoplast surface. Crystals were confined to cell walls except for a few found in vesicles with thickened membranes. Serial sections indicated that most vesicular structures with thickened membranes were in contact with the cell wall, but a few, including some which contained uranyl crystals, were within the protoplast. These results provide evidence of pinocytotic activity in intact plant cells exposed to a toxic heavy metal. (auth)

Nuclide Kinetics and Toxicology

Man

578 (COO-1231-82) CERTAIN ASPECTS OF RADIOSTRONTIUM METABOLISM IN MAN. Spencer, Herta; Kramer, Lois; Norris, Clemontain; Samachson, Joseph (Veterans Administration Hospital, Hines, Ill.). [nd]. Contract AT(11-1)-1231-82. 58p. Dep. NTIS.

Data on the metabolism of ^{85}Sr in man following oral administration of a tracer dose are reported. Topics covered include the effects of sable calcium and phosphates and the presence or absence of food in the intestine on ^{85}Sr absorption; factors that inhibit the intestinal absorption; the passage of calcium and strontium from the vascular space into the intestine; and the comparative removal of ^{85}Sr and ^{90}Sr from man. Some data on the uptake of ^{90}Sr in milk and other foods and excretion in urine and feces in relation to calcium content of the diet are included. The effects of administration of aluminum phosphate gel on the whole-body retention or removal of dietary ^{90}Sr, ^{85}Sr, and ^{47}Ca, as measured by whole-body counting, were also studied. Data from a number of animal studies on ^{85}Sr and ^{90}Sr are reviewed. (55 references) (C.H.)

579 DYNAMICS OF ^{90}Sr IN BONE TISSUE IN THE POPULATION OF THE SOVIET UNION FROM 1969 TO 1971. Marets, A. N.; Borusov, B. K. Gig. Sanit.; No. 7, 56-9(Jul 1972). (In Russian).

Data are reported on the uptake of ^{90}Sr in the human bone tissue samples collected during 1969 to 1971 in the Soviet Union in comparison to data accumulated since 1957. Results of 2,490 radiochemical analyses of bone tissue and extracted teeth of the inhabitants of 65 cities during the past three years were used as the source of data. A decrease in ^{90}Sr concentration in the skeleton was noted, however the rate of decrease has slowed down somewhat. The average for the country amounted to 1.1% of the permissible ^{90}Sr concentration previously established. (K.S.W.)

580 SOME REGULARITIES OF TRITIUM BEHAVIOR IN THE GROWING HUMANS. Rasin, I. M. Med. Radiol.; 17: No. 10, 49-53(Oct 1972). (In Russian).

Coming from the supposition that behavior of tritium in the organism is subjugated to the regularities of the water metabolism between the organism and the external medium, a calculation was made of the changes of the effective period of half-retention of tritium depending upon age. It was shown that the effective half-life (T_{ef}) during the first days of the life of the human being was equal to 8 days, then by 20 days it decreased down to 3.5 days.

Later, T_{ef} increased linearly reaching the value of 11 to 12 days by 20 yrs. (auth)

Animals

Refer also to abstracts 437 and 537.

581 (COO–119-246) RESEARCH IN RADIOBIOLOGY. Annual Report of Work in Progress in the Internal Irradiation Program. Dougherty, Thomas F. (Utah Univ., Salt Lake City. Radiobiology Div.). 31 Mar 1972. Contract AT(11-1)-119. 380p. Dep. NTIS.

Separate abstracts were prepared on 22 sections of this report. (C.H.)

For abstracts of individual sections see: 575, 576, 582–599, 1567, and 1577.

582 (COO–119-246, pp 8-105) CURRENT CENSUS OF THE BEAGLE COLONY. 31 Mar 1972.

In Research in radiobiology.

Toxicity of the following nuclides was studied: ^{252}Cf, ^{249}Cf, ^{241}Am, ^{239}Pu, ^{228}Th, ^{228}Ra, ^{226}Ra, ^{224}Ra, ^{210}Pb, and ^{90}Sr. Experimental animals are divided into two groups designated as toxicity animals and test animals. Toxicity animals are those animals that will be maintained until sacrifice becomes a clinical necessity; test animals may be sacrificed as needed for special studies. The following data for both groups of animals are presented in the form of tables: age and weight of dogs at the time of injection; date of injection; number of days following injection at which death occurs; and dose to skeleton. (H.L.W.)

583 (COO–119-246, pp 106-25) ANATOMIC DISTRIBUTION OF MONOMERIC AND POLYMERIC ^{239}Pu. Taylor, G. N.; Jee, W. S. S.; Dell, R.; Williams, J.; Shabestari, L. 31 Mar 1972.

In Research in radiobiology.

Polymeric ^{239}Pu given intravenously to beagles was retained principally in the reticuloendothelial cells (RE) of the liver and the spleen. Retention in the skeleton was limited to the RE cells of the bone marrow with very little, if any, uptake in the bone proper. Except in the lung, where some mechanical filtration of larger particles may have occurred, the retention was principally governed by phagocytic factors. (auth)

584 (COO–119-246, pp 126-36) SKELETAL RETENTION AND DISTRIBUTION OF POLYMERIC AND MONOMERIC ^{239}Pu IN BEAGLES. Atherton, D. R.; Stover, Betsy J.; Jee, W. S. S.; Stevens, W.; Bruenger, F. W. 31 Mar 1972.

In Research in radiobiology.

Plutonium-239(IV) was given intravenously to beagles in: the Pu-transferrin complex (Pu–T_f), the 0.08 M citrate buffer (Pu–M), and as a suspension of near colloid size particles (Pu–P) at pH ~ 6. As expected, the overall distribution of the polymeric form of plutonium does not resemble that observed when it is administered as the monomeric complex with citrate or transferrin. The skeletal retention of plutonium, when injected in a monomeric form, is 50% of the injected dose. The retention of Pu–P in the skeleton was less than $\frac{1}{20}$ that seen in Pu–M or Pu–T_f at comparable times. The uniformity of skeletal distribution of Pu–P from bone to bone is markedly less than that seen with the two monomeric forms. Reduced skeletal retention in animals injected with Pu–P indicates a different skeletal retention mechanism in animals injected with polymeric plutonium. Autoradiographs clarify this point. (auth)

585 (COO–119-246, pp 137-47) EFFECT OF THE PHYSICAL–CHEMICAL STATE OF ^{239}Pu ON ITS EARLY RETENTION IN PLASMA AND SELECTED SOFT TISSUES OF BEAGLES. Stevens, W.; Atherton, D. R.; Stover, Betsy J.; Bruenger, F. W. 31 Mar 1972.

In Research in radiobiology.

The early distribution and retention of ^{239}Pu in plasma, kidney, spleen, and other selected soft tissues were studied in beagles after intravenous injection of the strictly monomeric Pu-transferrin complex (Pu–T_f), PuIV in citrate buffer of pH 3.5 (Pu–M), and polymeric plutonium (Pu–P) prepared by differential precipitation from a purified solution of plutonium nitrate. It was given at pH ~ 6. Pu–T_f was removed from the circulation at a rate slower than Pu–M, whereas, Pu–P initially left the blood at a very rapid rate. At 15' after injection 87%, 64%, and < 2% of the three forms of plutonium were circulating in plasma respectively; 100% of Pu–T_f and the larger fraction of Pu–M were protein bound. No protein binding of Pu–P was seen. At two weeks after injection, the concentration of plutonium in most soft tissues was quite similar for Pu–T_f and Pu–M. Compared to Pu–M, kidney retention was less by a factor of 20, whereas, spleen retention was elevated by a factor of 10 in the Pu–P injected animal. The concentration of Pu–P in the spleen was 1.6 times greater than the concentration in the liver. Following differential centrifugation of tissue homogenates from Pu–P injected animals, the percentage of plutonium in the soluble fraction was greatly reduced in spleen but not in similar fractions of kidney when compared to Pu–T_f and Pu–M injected dogs. Most of the nuclide in the kidney was found in the fraction rich in mitochondria. In the case of Pu–P, a large concentration of plutonium also was found in the nuclear fraction of spleen homogenates. The concentrations of plutonium in thyroid, adrenal, pituitary, dura mater, subcutaneous loose connective tissue and other soft tissues are compared. (auth)

586 (COO–119-246, pp 148-60) EFFECT OF THE PHYSICAL–CHEMICAL STATE OF PLUTONIUM ON ITS EARLY DISTRIBUTION IN THE LIVER. Bruenger, F. W.; Stevens, W.; Atherton, D. R.; Stover, Betsy J. 31 Mar 1972.

In Research in radiobiology.

The early deposition and subcellular distribution of ^{239}Pu in canine liver following administration of either strictly monomeric PuIV as a transferrin complex (Pu–T_f), PuIV in citrate buffer pH 3.5 (Pu–M), or largely polymeric PuIV in nitrate pH 6 (Pu–P) have been studied. Large differences in the quantities deposited and the intraorgan distribution pattern in the liver were observed. Liver depositions ranged from 25% of total dose for the strictly monomeric (Pu–T_f), an average of 32% for Pu–M, to ~70% for the largely polymeric material. Autoradiographs show that initially Pu–M was deposited uniformly and diffusely in hepatic cells whereas Pu–P was found largely in random clusters in R. E. cells. Cellular distribution patterns of Pu–T_f and Pu–M injected dogs were quite similar. Liver homogenates from a dog injected with Pu–M and the animal injected with Pu–P also were studied by differential and isopycnic sucrose density gradient procedures. Monomeric plutonium was initially associated with soluble liver proteins, i.e., ferritin, and was found at later times with subcellular fractions rich in mitochondria and also with lysosomes. In these organelles, most of the nuclide was either membrane bound or possibly associated with heavy granular material. In liver homogenates obtained from dogs injected with Pu–P most of the nuclide sedimented with nuclei or mitochondria. No association of Pu–P with soluble proteins could be demonstrated at very short times after injection. (auth)

587 (COO–119-246, pp 161-6) CONCENTRATION OF ^{239}Pu(IV) IN THE BLOOD PLASMA OF THE BEAGLE. Stover, Betsy J.; Atherton, David R. 31 Mar 1972.

In Research in radiobiology.

The concentration of plutonium in plasma was measured from 1 minute to 12.5 years following injection of the young adult beagle with ^{239}Pu in 0.08 M citrate buffer, pH 3.5. On the average, there was a continuous decrease in the concentration of ^{239}Pu in plasma with time. (C.H.)

588 (COO–119-246, pp 167-92) COMPARISON OF SKELETAL AND HEPATIC DOSE RATES FROM ^{239}Pu IN THE BEAGLE AS A FUNCTION OF DOSE LEVEL. Stover, Betsy J.; Atherton, D. R.; Bruenger, F. W.; Stevens, W. 31 Mar 1972.

In Research in radiobiology.

The total skeletal retention has been measured in four beagles that were injected intravenously with 0.0059 μCi ^{239}Pu/kg in 0.08 M citrate buffer, pH 3.5. The dogs were young adults at the time of injection and they were sacrificed at 1648 to 2546 days after injection at which times the removal of plutonium from trabecular surfaces by remodeling had decreased significantly. Retention of plutonium in 8 humeri and 8 third lumbar vertebrae was measured in dogs at low dose levels which were sacrificed at 35 to 4375 days after injection. These results are combined with previous data on early deposition and retention in the skeleton, and early and long term data on retention in the humerus and third lumbar vertebra, to obtain a set of four skeletal retention equations applicable to at least seven dose levels. From measurements of the defleshed skeletons of 18 beagles, the indicated wet skeletal weight was 7.5 ± 0.9% of the weight of the dog at injection, a value lower than the previously assumed 10%. Using the set of skeletal equations, and the measured skeletal weight, the cumulative rads doses to the skeleton and the liver are compared. The average dose to the liver exceeds that to the skeleton except at the 2.8 μCi/kg dose level after 1300 days. (auth)

589 (COO–119-246, pp 193-217) QUANTITATIVE MORPHOLOGY OF VERTEBRAL TRABECULAR BONE IN BEAGLES INJECTED WITH PLUTONIUM. Jee, W. S. S.; Dell, R. B.; Hashimoto, E. 31 Mar 1972.

In Research in radiobiology.

The percentage of trabecular bone within the cortical bone envelope of lumbar vertebral bodies of beagles diminishes with age from a value of 25% at 500 days to a value of 16% at about 6000 days of age. Beagles injected with 2.7, 0.909, 0.301, 0.096, and 0.0485 μCi of ^{239}Pu/kg exhibit elevated percent trabecular bone

values, but were within normal range for their respective age groups in the beagles injected with 0.0157 μCi/kg. The dogs injected with 0.0157 to 2.7 μCi ^{239}Pu/kg show increased trabecular widths. In general, the effect of a single intravenous dose of plutonium results in the inhibition of bone resorption leading to thicker or mosaic trabeculae. (auth)

590 (COO-119-246, pp 249-62) SKELETAL DISTRIBUTION OF ^{241}Am AND ^{239}Pu IN BEAGLES: CAN THEY BE COMPARED? Lloyd, Ray D.; Mays, Charles W.; Jee, Webster, S. S.; Taylor, Glenn N. 31 Mar 1972.

In Research in radiobiology.

No statistical justification was found for rejecting data of a dog sacrificed 1 day after the injection of ^{239}Pu from the mean percent skeletal Pu per bone values which included data from 19 other dogs sacrificed 5 to 769 days after ^{239}Pu injection. An equivalent conclusion was drawn from corresponding data for dogs injected with ^{241}Am and sacrificed 1 and 7 to 1533 days later. Comparison of the mean skeletal distribution of retained Pu with retained Am emphasizes similarities more than differences. Whereas the relative distribution of Pu in the skeleton was not generally dependent upon time after injection, a highly significant relationship between relative skeletal distribution and burden time was revealed for Am, with vertebrae, tail, and sternum, which have much trabecular bone, exhibiting a decreasing fraction of retained Am with increasing time. (auth)

591 (COO-119-246, pp 263-5) ^{241}Am SKELETAL DISTRIBUTION IN BEAGLES. Lloyd, R. D.; Atherton, D. R.; Gaufin, Susan S.; Mays, C. W.; Taylor, G. N. 31 Mar 1972.

In Research in radiobiology.

Data are summarized on the distribution of ^{241}Am in various bones of the beagle skeleton. Tables are presented to show per cent of injected ^{241}Am in the total skeleton of ten beagles from one to 1533 days after injection and per cent of retained ^{241}Am in the different bones at various intervals up to 1917 days after injection. A transcribing error from an earlier report is corrected. (H.L.W.)

592 (COO-119-246, pp 266-71) TISSUE CONCENTRATION OF INJECTED ^{241}Am IN BEAGLES. Lloyd, Ray D.; Atherton, David R.; Taylor, Glenn N. 31 Mar 1972.

In Research in radiobiology.

The concentration (% injected activity/kg) of ^{241}Am in 16 beagles sacrificed 1 to 1917 days after injection is presented in tabular form. Tissues of highest concentration typically were found to be the liver, thyroid, skeleton, and kidney. In only 2 dogs was the skeletal concentration higher than that in the thyroid. Liver exhibited the highest concentration in all 16 animals. In a few individual dogs, some other tissues such as the dura, spleen, aorta, mesentery or lymphatics showed significant concentrations. (auth)

593 (COO-119-246, pp 284-6) ^{252}Cf, ^{249}Cf, ^{239}Pu, AND ^{226}Ra TOXICITY STUDIES IN MICE. Taysum, D. H.; Taylor, G. N. 31 Mar 1972.

In Research in radiobiology.

Objectives and experimental plans for toxicity studies in mice are described. It is expected that the five year pilot study will provide experimental evidence for cancer induction by ^{252}Cf. A table is presented to show expected bone sarcoma incidence following various levels of injection. (H.L.W.)

594 (COO-119-246, pp 287-8) ^{252}Cf PILOT STUDY IN BEAGLES. 31 Mar 1972.

In Research in radiobiology.

Injections of ^{249}Cf and ^{252}Cf were begun in February, 1971, for studies on life span of dogs. Experimental plans are described for future studies on effects of ^{249}Cf and ^{252}Cf on survival and development of bone and liver tumors in beagles. (H.L.W.)

595 (COO-119-246, pp 289-98) CALIFORNIUM RETENTION IN BEAGLES DURING THE FIRST YEAR AFTER INJECTION. Lloyd, Ray D.; Mays, Charles W.; Atherton, David R.; Gaufin, Susan S. 31 Mar 1972.

In Research in radiobiology.

Measurements of the retention of citrate complexed, intravenously injected ^{249}Cf and ^{252}Cf in the total-body and liver of beagles have been extended to one year after injection. The biological half-time of Cf in the total body appears to be in the order of 6 years. Sacrifice of 2 additional dogs for distribution studies confirmed earlier conclusion that liver, skeleton, thyroid, and kidney were the tissues with highest Cf concentration. Fission product iodine isotopes were found in the thyroid glands of Cf-252 injected dogs. (auth)

596 (COO-119-246, pp 299-306) DISTRIBUTION AND RETENTION OF ^{249}Cf IN BEAGLE SOFT TISSUE. Atherton, David R.; Lloyd, Ray D. 31 Mar 1972.

In Research in radiobiology.

Beagles injected intravenously with ^{249}Cf in citrate buffer of pH 3.5 were sacrificed 7 days and 3 weeks after injection. As with americium, the concentration of californium in the liver was highest of all soft tissue but the total was about 18 to 20%, whereas the beagle liver retains about 50% of injected americium at comparable times. Concentrations in other soft tissue ranged from 70% of that in the liver downward. The thyroid, kidney, spleen, lymphatic tissue and dura mater showed significant concentrations. The presence of californium was ubiquitous but in very low concentrations throughout all other soft parts; the brain, lungs, heart, gastrointestinal tract, pancreas, gonads, thymus, pituitary, and adrenals being measured specifically, as were large samples of fat, muscle and pelt. From these initial studies it is seen that of the soft tissues, liver, thyroid, and kidneys will be at greatest risk following administration of ^{249}Cf. (auth)

597 (COO-119-246, pp 307-18) INTRACELLULAR DISTRIBUTION OF ^{249}Cf IN CANINE LIVER. Bruenger, F. W.; Atherton, D. R.; Stevens, W. 31 Mar 1972.

In Research in radiobiology.

Three beagles were injected intravenously with ^{249}Cf in citrate buffer. One of these dogs was sacrificed at 7 days, another at 21 days; liver biopsies were performed on the third dog starting at one day after injection. Liver specimens from all dogs were homogenized in sucrose-Ca^{2+} and subjected to differential centrifugation. Most of the ^{249}Cf was initially bound by soluble proteins, probably ferritin. At later times increasing quantities were associated with intracellular organelles. Homogenate fractions free of nuclei and debris (homogenate after 6000 g-min) were subjected to centrifugation for 220,000 g-min in a continuous linear sucrose gradient of 12 to 52%. All fractions were collected and analyzed for ^{249}Cf, protein, acid phosphatase (lysosomal marker), and cytochrome c oxidase (mitochondrial marker). At one day after injection more than 50% of the nuclide was found in the three lightest fractions and approximately 10% in the three heaviest fractions. This pattern was reversed with time and at 21 days 10% was found in the lightest fractions and 43% in the heaviest fractions. At this time more than 50% of the nuclide in the liver was associated with the fraction collected at 60,000 g-min, designated as mitochondria. This fraction showed high cytochrome oxidase activity and also acid phosphatase activity. It is presently assumed that redistribution occurs from soluble proteins into mitochondria and then into lysosomes. Similar data have been obtained from kidney and spleen homogenates. (auth)

598 (COO-119-246, pp 319-30) INTERACTION OF ^{249}Cf AND ^{252}Cf WITH CONSTITUENTS OF DOG AND HUMAN BLOOD. Stevens, Walter; Bruenger, F. W. 31 Mar 1972.

In Research in radiobiology.

Beagles were injected with ^{249}Cf or ^{252}Cf in citrate buffer. The concentration of nuclide in plasma and whole blood was measured from 5 minutes to 48 hours post-injection. Small amounts of californium were found associated with the cellular elements. The concentration of californium in plasma decreased rapidly during the first few hours after injection. At twenty-four hours post injection less than 1% of the injected dose was circulating. Californium-249 and -252 disappeared from the circulation at the same rate. Separation of plasma constituents by gel filtration demonstrated that californium in plasma was associated with compounds with a molecular weight of approximately 70,000. Additional information obtained by ion exchange chromatography indicated that this protein was transferrin. Data obtained in vivo from canines were extended by in vitro experiments with human blood. Gel chromatography of a human plasma protein incubated in vitro with californium indicated that a Cf-protein complex was formed and appeared to be nearly identical to that seen in dogs. Rechromatography of these fractions on DEAC-Sephadex showed that transferrin and californium did not coincide exactly. Thus, californium-transferrin is either held more tenaciously by the ion exchange resin than iron-transferrin or apo-transferrin, or the shift was caused by the presence of another as yet unidentified minor protein component. The stability of the protein complex(s) formed is less than that of the plutonium-transferrin complex and this decreased stability is responsible for the high rate of its disappearance from the bloodstream. (auth)

599 (COO-119-246, pp 358-64) BIOCHEMICAL CHANGES PRODUCED BY LOW DOSE OF RADIATION. Nabors, Charles J. Jr. 31 Mar 1972.

In Research in radiobiology.

Beagles bearing ^{239}Pu burdens showed marked alterations in serum alkaline phosphatase and serum glutamic oxaloacetic transaminase and serum glutamic pyruvic transaminases. Low dose level animals appear to have a much longer latent period prior to the appearance of altered serum biochemistry than do animals with higher dose levels. (auth)

600 (TID-3910(Suppl.8)) TERRESTRIAL AND FRESH-WATER RADIOECOLOGY. A Selected E ɔliography. Klement, A. W. Jr.; Schultz, Vincent (Washington State Univ., Pullman. Dept. of Zoology). 1972. 148p. Dep. NTIS.

A total of 1,733 annotated references to recent publications on the radioecology of freshwater and terrestrial animals and plants is presented. This total includes 24 bibliographies. (C.H.)

601 RADIOIODINE UPTAKE AND RETENTION BY THE MULE DEER THYROID. Gist, Clayton S.; Whicker, F. Ward (Colorado State Univ., Fort Collins). Contract AT(11-1)-1156. J. Wildlife Manage.; 35: No. 3, 461-8(Jul 1971). (COO-1156-38).

Data are presented on uptake and loss rates of ^{131}I by the thyroid glands of captive mule deer (Odocoileus hemionus). Data were obtained by giving acute oral doses of Na ^{131}I to males and females of various ages during three seasonal periods and periodically measuring thyroid radioactivity with an external counter. Dose fractions appearing in the thyroid averaged 0.32 in winter, 0.22 in spring, and 0.20 in summer. Effective ^{131}I elimination half times averaged 6.5 days among all individuals, 5.7 days for juveniles, and 7.3 days for adults. Age and seasonal differences in ^{131}I uptake and loss rate were correlated with food and stable iodine intake and body weight. Thyroid ^{131}I activity reached maximum levels within 3 days after dosing. A mathematical model employing some of the parameters determined was found to be applicable to observed data on radioiodine levels in Colorado deer after contamination of the environment by products of nuclear fission. (auth)

602 STUDIES ON ARSENIC METABOLISM. 2. RELATIONSHIP BETWEEN THE WEIGHT AND ^{74}As UPTAKE RATE IN RATS AND RABBITS. Tsutsumi, Shoji; Goto, Kazuyoshi; Kizu, Hiroshi (Tokyo Dental Coll.). Nippon Shonika Gakkai Zasshi; 76: No. 1, 44-53(Feb 1972). (In Japanese).

In the uptake of ^{74}As in the lung, kidneys, liver, spleen, nails, and femur, there were differences between young and adult rabbit groups with examination of whole organs or parts of organs. Slight differences were observed between two groups in the heart, brain, skin, muscles, mandibula, incisors, and molars. There were differences in the uptake rate between three groups of rats, A(body weight of 10 to 15g), B(27 to 35g), and C(65 to 85g), per whole body and per 1g of organs. Uptake in the blood, spleen, kidneys, lungs, and liver was higher in group A rats, which were lighter and younger. The greatest difference in uptake rate was observed between groups B and C. With examination of 100 mg per organ, the uptake rate in the femur, incisors, and molars was very high in group A, low in B, and almost absent in C. Among the three groups, there was not much difference in the uptake rate in the heart. However, there were some differences in the hair and brain. Both in rats and in rabbits, differences in uptake were observed according to age. However, in the liver, where the uptake rate was relatively higher, the value was 100 $\mu g/g$ in both rabbits and rats. In the brain, where the value was less than 10 $\mu g/g$ — a very slight amount. (Japan)

603 L X-RAY MEASUREMENT OF ACTINIDE METABOLISM USING ^{243}Am IN MICE. Wright, S. R. (Univ. of California, Berkeley). Int. J. Appl. Radiat. Isotop.; 23: No. 9, 423-9(Sep 1972).

A method is described which uses L X-ray counting, rather than α-counting, for studies of the metabolism of certain actinide elements in mice. To demonstrate the effectiveness of this method, mice were injected with citrated ^{243}Am and two separate metabolic patterns were determined based on data obtained from two different photopeaks: One was from the L X-rays and the other from the 74 keV γ-ray. The results were comparable, and indicate L X-ray counting will be useful in studies of actinide elements that do not emit abundant γ-rays. (auth)

604 IRRADIATION LEVEL OF ORGANS AND TISSUES FOLLOWING INHALATION OF AIR CONTAINING RADON AND ITS SHORTLIFE DAUGHTER PRODUCTS. Andreev, S. V. Gig. Sanit.; No. 7, 46-50(Jul 1972). (In Russian).

Investigations carried out on animals dealt with the distribution of radon, RaA, RaB, and RaC in the organs depending on the time of inhalation of air containing radon and its daughter products. Taking into account the observation data on men, the author determined the levels of irradiation of organs and tissues in man due to his presence in the air containing radon. When sharp changes take place in the radioactive balance between radon and its daughter products in the inhaled air the role of the critical organ is transferred from the lungs to the kidneys. (auth)

605 EFFECT OF pH ON THE ACCUMULATION AND DISTRIBUTION OF ^{89}Sr IN SKIN. Norets, T. A.; Il'in, L. A.; Shamov, V. P.; Shvydko, N. S. Gig. Sanit.; No. 7, 50-6(Jul 1972). (In Russian).

The effect of solution acidity on the accumulation level and the type of radioactive strontium distribution in the skin was studied experimentally on rats. The authors examined solutions with pH levels ranging from 2.0 to 10.5, i.e., within the limits that cause no apparent skin lesions. The solution pH values were shown to affect the extent of entry into the skin of even such elements that were in an ionodispersed state at all the investigated pH levels. (auth)

606 INTERACTION OF ^{210}Po WITH BIOLOGICAL SUBSTRATES OF THE LIVER. Shvydko, N. S.; Mukhailova, O. A.; Porov, D. K. Gig. Sanit.; No. 7, 111-12(Jul 1972). (In Russian).

White rats were intravenously administered either a single dose of ^{210}Po (as the chloride) or repeated doses over the course of three months. The ^{210}Po uptake by liver was determined by ashing samples, electrochemically precipitating the isotope on Ni discs, and counting the α particles emitted. The approximate fractions of ^{210}Po that appeared in different portions of the liver were: in lipids, 18%; in water soluble proteins, 16%; in scleroproteins, 47%; and in protein-free extract, 4%. An investigation of livers of animals receiving chronic administration of ^{210}Po showed: in lipids, 4%; in water soluble proteins, 48%; in scleroproteins, 48%; and in protein-free extract, 4%. These differences in ^{210}Po distribution are discussed. (K.S.W.)

607 STUDIES ON RADIOACTIVE COLLOIDS AFFECTING PHAGOCYTOSIS IN BONE MARROW OF RABBITS. Ito, Yasuhiko; Takahashi, Kunibumi; Sato, Tachio (Tohoku Univ., Sendai). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 11, 101-6(Feb 1971). (In Japanese).

The effects of various colloidal preparations on the distribution of radioactive colloids in the reticuloendothelial (R-E) cells of the liver and bone marrow of rabbits were studied. Colloids of sodium chondroitin sulfate, gelatin, dextran, and P.V.P. were added separately to an ^{113m}In solution that was prepared by Wagner's method. Besides these colloids, ^{198}Au colloids of various particle sizes, ^{113m}In-sulfur-antimony colloids, ^{113m}In-stannous oxide colloids, ^{99m}Tc-sulfur colloids, ^{99m}Tc-sulfur-antimony colloids and ^{59}Fe-sodium chondroitin sulfate colloids were used in the experiment. Tissue uptake results were expressed as the ratio of net cpm per gram of marrow to that of liver, i.e., marrow to liver ratio. The most significant bone marrow uptake was demonstrated in the marrow to liver ratio of ^{113m}In-sodium chondroitin sulfate colloids, 3.1 times as great as that of ^{198}Au. This value did not decrease significantly in a sterilized preparation with Millipore-filter particle size of 0.45 micron. The marrow to liver ratios of ^{59}Fe-chondroitin sulfuric acid colloids and ^{99m}Tc-sulfur-antimony colloids were slightly higher, compared with that of ^{198}Au colloids. The ratio of ^{99m}Tc-sulfur colloids and ^{113m}In-sulfur-antimony colloids were nearly the same as that of ^{198}Au colloids. The autoclaved colloids that were prepared using protective colloids, such as sodium chondroitin sulfate, gelatin, and dextran, were taken up less by R-E cells of the marrow than was ^{198}Au. The number and size of particles of radioactive colloids are important factors in phagocytosis by bone marrow R-E cells; however, the greatest factor affecting colloidal distribution appears to be the physicochemical nature of the colloids. (auth)

New Tracer Techniques

608 (LBL-1303) BYPASS FLOW AND TISSUE PERFUSION: A DUAL TRACER DETERMINATION. Goris, M. L.; Dobson, E. L.; Schmidt, C. T.; Parker, H. G. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 193p. Dep. NTIS.

Thesis submitted by M. L. Goris.

The density function of transit times of a tracer through a vascular or perfusion system contains information about the flow of carrier and the distribution volumes of the tracer. To derive the density function of transit times from observational data, one has to correct the latter for recirculation. This is done by independently estimating the effect of recirculation on a known density function of transit times (in this case a delta function). It is shown how the tissue perfusion of an organ can be estimated from the density function of transit times of a diffusable tracer injected into the organ, and how an error in this estimation results if bypass or shunting is not accounted for. The physiological significance of this shunting is reviewed, and it is shown how the shunting fraction of the flow can be estimated from the simultaneous analysis of the density functions of transit times of a diffusable and a non-diffusable tracer. The method was tested using the hind limb of a dog and ^{99m}Tc-labeled colloid and ^{133}Xe as tracers. The results are consistent with observations on the bypass flow made by other means. (auth)

609 SOLID PHASE RADIOIMMUNOASSAY METHOD FOR PLASMA FOLLICLE STIMULATING HORMONE BY THE DISPQSABLE MICROTITER PLATE. Fukase, Masaichi; Nakano,

Yutaka; Nagayama, Yoichi (Kyoto Univ.). Naika Hokan; 19: No. 3, 79-87(Mar 1972). (In Japanese).

A new, easy, sensitive, and rapid radioimmunoassay method was devised for the determination of human follicle stimulating hormone (FSH) level in plasma. FSH and the anti-FSH-serum of the radioimmunoassay set for human FSH supplied by Calbiochem. K.K. and the disposable microtiter plate supplied by Cooke E. Co. as a solid phase were applied to the procedure of the method. All the process of our method finished in 24 hrs and FSH in doses of 0.1 mIU per ml of plasma was detectable using only 0.1 ml of plasma. This method showed a high specificity for the immunoassay of FSH. FSH levels determined by this method were almost identical with those determined by Midgley's double antibody method with the same samples. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 12, 96, 108, 150, 218, 231–234, 407, 723, 725, 740, 744, 747, 784, 809, 861, 1841, 1845, 1869, 1877, 1888, 1898, 1983, 1986, 2010, and 2159–2164.

610 (COO–1441-18) THERMODYNAMIC STUDY OF NONSTOICHIOMETRIC CERIUM DIOXIDE. Panlener, R. J.; Blumenthal, R. N. (Marquette Univ., Milwaukee, Wis. Coll. of Engineering). 1972. 34p. Dep. NTIS.

Thermogravimetric measurements were performed on nonstoichiometric CeO_{2-x} in the temperature range 700 to 1500°C and from oxygen pressures of 10^{-1} to 10^{-26} atm. From this data the deviation from stoichiometry $x = x(T, P_{O_2})$ was determined. The thermodynamic quantities $\Delta\bar{H}_{O_2}$ and $\Delta\bar{S}_{O_2}$ were calculated in the region $\leq 0.0003 \times \leq 0.3$ and found to be independent of temperature. In the composition region $x < 0.001$, the thermogravimetric data is assumed to be influenced by impurities. In the region $<0.001 \times <0.01$, the variation of $\Delta\bar{S}_{O_2}$ with x is consistent with a defect model involving randomly distributed doubly ionized oxygen vacancies. The experimental $P_{O_2}^{1/6}$ dependence of x is rationalized on the basis of the above model and the observation that $\Delta\bar{H}_{O_2}$ ($\approx$9.8 eV) exhibits a slight dependence on x. It is postulated that the variation in $\Delta\bar{H}_{O_2}$ results from an increase in the lattice parameter with x. In the composition region $<0.01 \times <0.1$, $\times \propto P_{O_2}^{1/n}$ with $1 < n < 5$, and in the region $0.3 > \times > 0.1 \times \propto P_{O_2}^{1/n}$ with n increasing rapidly with x to $n \simeq 30$. This behavior is believed to be a manifestation of increasing defect interaction with increasing departures from stoichiometry. It is interesting to note that the ordered phase observed by Bevan and Kordis between $CeO_{1.72}$ and $CeO_{1.70}$ was not observed in this study at temperatures between 1300 and 1500°C. (auth)

611 (COO–1441-19) STUDY OF THE DEFECT STRUCTURE OF NONSTOICHIOMETRIC CeO_2. Progress Report. Blumenthal, R. N. (Marquette Univ., Milwaukee, Wis. Coll. of Engineering). 1972. Contract AT(11-1)-1441. 34p. Dep. NTIS.

Based on a combined analysis of electric conductivity and thermodynamic data the conductivity, in the temperature range 700 to 1000°C, may be represented by $\sigma \propto xe^{-Q/kT}$ where Q is a function of x. This expression was rationalized in terms of the following simple relations for the electron carrier concentration $[Ce'_{Ce}] \propto x$ and the electron mobility $\mu = \mu_0 e^{-Q/kT}$ where μ_0 is independent of x, Q is independent of x from $-3.0 < \log x < -1.8$, and Q increases with x from $-1.8 < \log x < 0.7$. The electric conductivity data on CaO-doped CeO_2 (0.1–16 mole%) which involves both ionic and electronic transport has been interpreted in terms of an oxygen vacancy model. Preliminary conductivity measurements on SrO-doped CeO_2 indicate that the P_{O_2} dependence of σ was approximately the same for both CaO and SrO_2 doped specimens. However, the mobility of oxygen vacancies appears to be larger in SrO-doped CeO_2. The results of the ionic transference measurements on CeO_2 doped with 2, 5, and 14 mole % CaO in the temperature and oxygen pressure ranges 700 to 1000°C and 1 to 10^{-22} atm are discussed. The results of a thermodynamic study on CeO_{2-x}, where x was measured in the composition region $0.0003 \leq x \leq 0.3$ as a function of T and P_{O_2}, are also discussed. The thermodynamic quantities $\Delta\bar{H}_{O_2}$ and $\Delta\bar{S}_{O_2}$ were calculated from this data. On the basis of the observed dependence of $\Delta\bar{S}_{O_2}$ on x, the nonstoichiometric behavior of CeO_{2-x} was rationalized in terms of the defect reaction $2Ce^{x}_{Ce} + O^{x}_{O} = V^{\cdot\cdot}_{O} + 2Ce'_{Ce} + \frac{1}{2} O_2(g)$ in the composition region $10^{-3} < x < 10^{-2}$. (auth)

612 (GERHTR–2) MODEL STUDIES ON CONICAL FLUIDIZED BEDS. A CONTRIBUTION TO FUEL PARTICLE COATING. Wallroth, C.-F. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of report JUL–669-RW. 197p. Dep. NTIS.

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

Activities are reported on programs directed to the simulation of movement phenomena occurring in high-temperature fuel particle coating beds at room temperature and to optimization of the fluidized bed conditions, in order to improve pyrolytic carbon deposition conditions in relation to the polyhedral properties of the coated particles. The theoretical principles applied for determining the conditions in the coating bed and for creating a physical similarity in the model bed are reviewed. A model experiment was conducted to investigate the influence of gas flow, gas distribution, particle loading, and bed and jet geometry on particle movement. Results of experiments with variation of the jet geometry showed that the jet outlet velocities are the governing factor for the form of movement. With a large central jet surface the spouting movement disappears. Results of experiments at different cone aperture angles showed that the most favorable conditions were obtained at $\alpha = 30°$ (stable bubble movement, good particle circulation). Results of experiments with different bed diameters have shown that relatively good turbulent layers are produced in the 1-inch bed, whereas with larger bed geometries very inhomogeneous conditions obtain as a result of the low particle concentration in the central coating zone, thus giving rise to unfavorable coating conditions. A cyclone bed has been developed in order to improve the flow conditions. (J.R.D.)

613 (LA–3329) IMPROVED PERFORMANCE OF W-BASED UO_2 FUEL MATERIALS. Lenz, William H. (Los Alamos Scientific Lab., N. Mex.). 1 Jun 1965. Contract W-7405-eng-36. 18p. Dep. NTIS.

Declassified 26 Oct 1972.

Previous work (published) revealed high UO_2 losses on bare $W-UO_2$ specimens at 2350°C in flowing H_2; 2-mil coats of sprayed-powder W or deposits from W-carbonyl greatly reduced losses. Cracking of W-coated cermets was traced to hydriding of free U during cooling after UO_2 exposure to 2200°C or higher. A more ductile matrix (W–25% Re) resisted cracking better and further reduced UO_2 losses even at 2600°C. Sintered density, melting point, grain size, and ductility following high temperature exposure were obtained on more recent work. These data combined with UO_2-loss tests suggested that total performance was related to improvements in several categories: impervious W-coats by W-fluoride deposition; greater matrix ductility by grain size restriction and alloying with Mo and Re, yet retaining melting point above 3000°C; high temperature stabilization of UO_2 by Y_2O_3; and high sintered density of the cermets. With 2 to 6-mil W-coats, UO_2 losses on thin specimens of 40 vol % UO_2 cermets have been reduced to 0.1 to 0.3% for periods up to $2\frac{1}{2}$ h in H_2 at 2600°C, even when cycled 30 times to a black heat. Similar cermets containing 4 vol % Y_2O_3, with 4-mil W-coats, when cycled every 30 min, have shown test life at 2600°C up to 8 h with only 1% fuel loss. (auth)

614 (ORNL–TM–3895) EXAMINATION OF IRRADIATED URANIUM NITRIDE FUEL CLAD WITH TUNGSTEN–RHENIUM OR T-111 ALLOY. Cuneo, D. R.; Long, E. L. Jr.; Jostsons, A.; Washburn, T. N. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 46p. Dep. NTIS.

Three fuel pins containing UN pellets were irradiated in the thermal neutron flux of the ORR for 5800 h to a peak burnup of 1.75 at.%. The pin with W-25% Re cladding performed satisfactorily with the cladding outer surface at 1300°C. The two pins with T-111 (Ta–8% W–2% Hf) cladding, which had an inner liner of chemically vapor deposited tungsten, operated with the cladding outer surface at 1400°C. The T-111 on one of the pins failed during the test by intergranular fracture. The grain size in the failed region was 6 times that in the gas plenum region, indicating that failure was caused by a localized hot spot. However, numerous cracks and cavities were found in other regions of the T-111 cladding of both the failed and unfailed pins, and it is concluded that the cladding on both of these pins would have ultimately failed without the hot spot. Hafnium-rich areas, with concentrations 30 to 40 times that in the homogeneous alloy, were detected by electron microprobe examination at the cracks and cavities in both the T-111 and the tungsten liner. The mechanism of the test-induced concentration of hafnium was not determined. The UN fuel performed satisfactorily in all three pins. The fission-gas release was only 0.1% at 1380°C (top pin) and 7.1% at 1500°C (bottom pin). Swelling of the fuel was adequately restrained by the cladding and was limited to closing of the as-fabricated 0.005-in. gap between fuel and cladding. No gross chemical reaction occurred between the fuel and cladding. Although they interacted to a depth of about 20 μm, electron microprobe analysis of the cladding revealed no uranium penetration beyond that depth. Nitrogen released from the UN may have interacted with the T-111 and led to the degradation of its mechanical properties. (auth)

615 (RD/B/N–2373) TRANSPORT KINETICS IN FACETED BUBBLES. Beere, W. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug 1972. 12p. Dep. NTIS (U. S. Sales Only).

A modified nucleation rate controlling mechanism of bubble

migration is presented and compared with the data for random migration of microscopic bubbles in neutron-irradiated UO_2. An expression is also derived for the velocity of directed motion under the action of a force and is applied directly to migration in temperature gradients. (auth)

616 TEXTURAL STUDIES OF CERAMICS. Conference Held at London, England, December 16, 1970. Proc. Brit. Ceram. Soc.; No. 20, 1-369(Jun 1972). (CONF-701230).

Eighteen papers were presented at the conference. A separate abstract was prepared for each of four papers. Papers for which no abstracts were prepared are concerned with experimental techniques and microscopic techniques. (J.R.D.)

For abstracts of individual papers see: 617–620.

617 PARTICLE GROWTH AND CREEP RATE IN A FINELY-DISPERSED UO_2–Mo CERMET. Huebner, H. (Siemens AG, Erlangen, Ger.); Ilschner, B. Proc. Brit. Ceram. Soc.; No. 20, 149-64(Jun 1972).

From Textural studies of ceramics conference; London, England (16 Dec 1970). See CONF-701230.

Particle coarsening and creep behavior were investigated on UO_2–Mo cermets prepared for use as nuclear fuel in thermionic emitters. The cermets contained 30% v/v ceramic phase with a mean diameter of only 1.4 μm, dispersed in a coherent metal matrix. Heat treatment resulted in coarsening of the UO_2 dispersion. The shift of the UO_2 particle diameter distribution towards larger values was measured as a function of time and temperature. Diffusion of uranium and oxygen via the grain boundaries of the molybdenum matrix is proposed as a mechanism, at least up to 1800°C, with an activation energy of about 60 kcal/mole. The stationary creep rate of the material was measured in the range 5 to 100 N/mm^2 at temperatures of 1450 to 2010°C. The stress-dependence is characterized by a power function with $n = 1.9$, as compared to Mo and UO_2 with $n \approx 4$ to 6. The activation energy for creep was found to be 93 ± 5 kcal/mole. The creep rate of the cermet is considerably higher than that of molybdenum. The cermet becomes more creep resistant with increasing diameter of the ceramic phase. The observed creep phenomena are interpreted as being due to phase and grain-boundary sliding, as in superplasticity. (auth)

618 SOME FRACTURE AND ELASTIC PROPERTIES OF COMPOSITE FUEL ANNULAR BODIES. Ashford, J. P.; Hodgson, J. C. (Central Electricity Generating Board, Berkeley, Eng.). Proc. Brit. Ceram. Soc.; No. 20, 165-87(Jun 1972).

From Textural studies of ceramics conference; London, England (16 Dec 1970). See CONF-701230.

Fracture and elastic properties for composite fuel annuli are derived from experiments undertaken on annular compacts loaded in compression. The advantages of this technique for post-irradiation examination of compact fuel are explained and proposals for using such a technique are made. A unique criterion for fracture for the composite fuel body is not available, though one based on the proposals of Losty and Orchard (1961) when applied to graphite is shown to have some applicability in the range of interest (e.g., strengths of between 0.2 to 1.5 kg/mm^2). The relationship between tensile strength (obtained from pressure burst tests) and tensile strengths (obtained from diametral compression tests) is shown to be: $\sigma(\text{Burst})/\sigma$ (Diametral compression) $\simeq 0.72$. (auth)

619 STRENGTH/GRAIN-SIZE EFFECTS IN CERAMICS. Rice, R. W. (Naval Research Lab., Washington, D. C.). Proc. Brit. Ceram. Soc.; No. 20, 205-57(Jun 1972).

From Textural studies of ceramics conference; London, England (16 Dec 1970). See CONF-701230.

Strength/grain-size, S/G, data are surveyed for a variety of ceramics including halides, oxides, nitrides, borides and carbides. Materials covered include UO_2, ThO_2, BeO, ZrO_2, SiC and graphite. All data are consistent with an equation of the form $S = M + HG^{-\frac{1}{2}}$ where M and H are normally constants for a given condition. For tensile strengths, M can depend on surface finish and internal stresses, but normally is greater than zero for materials of low and intermediate hardness (e.g., through most oxides, including Al_2O_3). This is discussed in terms of microplastic processes and M is shown to be of the order of 1% of the microhardness for many materials, while the case M = 0 is compared with Griffith behavior. Much of the effect of stoichiometry, impurities and additives on strength is shown to be due to changes in grain size. The limited compressive-strength data are also surveyed and found to satisfy the above equation, when $M > 0$ and much larger than for tensile strengths. Reasons for these tension/compression differences, implications of tensile values of M on surface-finish effects, porosity corrections and grain-size analysis are also discussed. (auth)

620 RELATIONSHIP BETWEEN TEMPERATURE AND ENVIRONMENT, TEXTURE AND STRENGTH OF SELF-BONDED SILICON CARBIDE. McLaren, J. R.; Tappin, G.; Davidge, R. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Proc. Brit. Ceram. Soc.; No. 20, 259-74(Jun 1972).

From Textural studies of ceramics conference; London, England (16 Dec 1970). See CONF-701230.

The bend strength of self-bonded silicon carbide has been determined from room temperature to 1300°C in air and to 1750°C in argon. Strength is invariant with temperature up to the melting-point of silicon when an ~60% drop in strength occurs; from the melting-point of silicon to 1600°C, the strength is invariant at the lower value. At higher temperatures there is a small increase in strength. Under all conditions and temperatures, fracture is brittle in nature. But, at temperatures just below the silicon melting-point and at low strain rates, there is a region of sub-critical crack-growth associated with plasticity in the silicon phase. This means that the toughness but not the strength increases with increase in temperature. (auth)

621 CERAMICS. Garnsworthy, C. (BDH Chemicals Ltd., Poole, Eng.). pp 401-9 of Ultrapurity: Methods and Techniques. /Zief, Morris (ed.). New York; Marcel Dekker, Inc. (1972).

The highlights of ceramics that merit consideration for the containment of high-purity materials are given. The materials discussed include aluminum nitride, aluminum oxide, beryllium oxide, boron nitride, calcium fluoride, calcium fluoride–magnesium fluoride, calcium oxide, cerium oxide, cerous sulfide, magnesium meta-aluminate (Spinel), magnesium oxide, silicon carbide, silicon nitride, thorium oxide, yttrium oxide, zinc oxide, zirconium oxide, and zirconium silicate (zircon). (P.C.H.)

622 FAST REACTOR IRRADIATION OF BORON CARBIDE POWDER. Pitner, A. L. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 3, 410-17(Nov 1972).

Boron carbide powder of natural enrichment compacted into type 304 stainless steel tubes was irradiated in the EBR-II at temperatures of 1190 to 1350°F to exposures as high as 5% burnup of the ^{10}B atoms. Particle breakup, microstructural effects, boron carbide/cladding interaction, and gas release were determined. The irradiation behavior was strongly dependent on temperature in the range investigated. (auth)

623 DOUBLE OXIDE $La_4U_3O_{14}$. Kovba, L. M. Vestn. Mosk. Univ., Ser. II. Khim.; 13: No. 3, 341-2(1972). (In Russian).

Uranium and lanthanum atoms in the double oxide $La_4U_3O_{14}$ are ordered regularly. The system U_3O_5–La_2O_3 was shown not to be quasibinary. (auth)

624 PHASE ANALYSIS OF ALLOYS OF THE Mo–Zr–C SYSTEM. Sosulina, I. A.; Medvedev, A. A.; Orlov, V. V. Ind. Lab. (USSR) (Engl. Transl.); 38: No. 3, 343-5(Mar 1972).

Translated from Zavod. Lab.; 38: No. 3, 275-7(Mar 1972).

Studies were made on the anodic polarization of metallic Mo (99.93%), Mo–Zr (1.64%)–Zr (1.64%)–C (0.08%) alloy, and phase standards of zirconium carbide and molybdenum carbide. The percentage Zr observed in the precipitates was higher than stoichiometric and was in the limit 1.09 to 1.19 corresponding to the ratio 50 at. % Zr to 46 to 42 at. % C in the zirconium carbide lattice. It was confirmed that in the precipitates all of the carbon is combined with zirconium in the carbide. The presence of amorphous oxides and hydroxides of Mo was confirmed by the formation of crystalline phase Mo_2O_3 in the precipitates during roasting in vacuum at temperatures of 500 and 1000°C. It was also found that during electrolysis with controlled current density selective isolation of zirconium carbide at a current density should not exceed 0.05 A/cm^2. (P.C.H.)

625 LOW TEMPERATURE PHASE TRANSITIONS IN V_4H_3. Westlake, D. G.; Ockers, S. T.; Mueller, M. H.; Anderson, K. D. (Argonne National Lab., Ill.). Met. Trans.; 3: No. 7, 1709-10(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

Tetragonal V_4H_3 was examined by the Debye–Scherrer technique and by x-ray diffractometry at temperatures below 300°K. Two structural transitions were indicated. The observable changes in metal–metal atom distances may be manifestations of hydrogen ordering. (auth)

626 GROWTH KINETICS OF DISPERSED THORIA IN Ni AND Ni–Cr ALLOYS. Footner, P. K.; Alcock, C. B. (Univ. of Toronto). Met. Trans.; 3: No. 10, 2633-7(Oct 1972).

The growth rates of dispersed thoria particles in nickel have

been measured as a function of time at 1350°C in gases of two separate oxygen partial pressures. Samples were prepared for electron microscopic study after these treatments for particle size distribution measurements. The diffusion coefficient and solubility of thorium in nickel placed in contact with thoria were also determined under the same conditions. The results of the measurements then provide the necessary information for the elucidation of the kinetics of Ostwald ripening in the ThO_2–Ni system. A linear relationship was found between the cube of the mean radius of the dispersed particles and the time at temperature. Substitution of the experimental results into the Lifshitz–Wagner equation for particle growth under diffusion control yielded values of the ThO_2–Ni solid–solid interfacial energy, which were in good agreement with what was expected by comparison with the corresponding solid oxide–liquid metal interface. Further studies were made of the coarsening of thoria in 20% Cr–Ni alloys. It was found that the enhanced rate of particle growth could be accounted for by the increased value of the diffusion coefficient of thorium in the alloy over the value in pure nickel. (auth)

627 PREPARATION OF ALUMINUM–BORON AND ALUMINUM–TITANIUM–BORON ALLOYS. Napalkov, V. I.; Khodakov, P. E.; Mitvol, L. S. Tekhnol. Legkikh Splavov, Nauch.-Tekh. Byul. VILSa; No. 3, 95-7(1970). (In Russian).

Studies were made on ways to improve the assimilation of B in the preparation of alloys. Assimilation of B from B_2O_3 into Al under a cryolite layer at 1200°C was 50% in 30 min (1 : 1 ratio being obtained) and from KBF_4 under a KCl layer at 950 to 970°C, 75 to 92% in 60 min. Alloys of Al with Ti and B can be prepared by introducing Ti cuttings with the KBF_4 under a KCl layer. (Referativnyi Zh.)

628 VIBRATION COMPACTION OF DISPERSED FUEL ELEMENTS FOR NUCLEAR REACTORS. Zhivanovich, B.; Mikiel, V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 93-9(May 1972). (In Russian).

Theoretical considerations of particle size distribution and weight ratios of different fractions are discussed from the viewpoint of maximizing the packing density in tubes and other shapes for use as reactor fuel elements. The dimensions of the jacket relative to the diameter of the coarsest fraction play an important role. Measurements of actual density distributions were made with a gamma meter and showed excellent agreement with calculated values. The advantages of vibration compaction are explained. (K.S.W.)

629 BINARY PHASE DIAGRAMS OF SOME ELEMENTS WITH BORON (REVIEW). Portnoi, K. I.; Romashov, V. M. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 48-56 (May 1972). (In Russian).

A review is given of research concerning the investigation of binary alloys of zirconium, hafnium, tantalum, chromium, molybdenum, tungsten, rhenium, iron, nickel, and silicon with boron. (44 references) (auth)

630 REACTION BETWEEN ZIRCONIUM AND SILICON WITH EXCESS CARBON. Rakcheeva, V. I.; Mashkovich, L. A.; Perkova, G. A.; (and others). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 57-61(May 1972). (In Russian).

The results of heating a powdered mixture of C–Si–Zr under different conditions are summarized: calcination at 900°C produced C + ZrO_2 + Si, thermomechanical treatment at 1,200 to 1,800 yielded C + ZrC + SiC, but at 2,000 to 2,800°C yielded C + ZrC + SiC_α. The interplanar distances in the crystalline products were studied as a function of the temperature of the thermomechanical treatment. (K.S.W.)

631 SULFIDATION OF BINARY IRON ALLOYS CONTAINING CERIUM OR LANTHANUM. Kor, G. J. W. (U. S. Steel Corp., Monroeville, Pa.). Met. Trans.; 3: No. 10, 2705-6(Oct 1972).

Studies were made to determine the stoichiometry of the rare earth sulfide formed upon sulfidation of solid iron containing Ce or La. It was found from the results that the solubility product of Ce and La sulfide in solid Fe at both 1200 and 1025°C was too small to be measured by the standard combustion iodometric method. However, it was deduced that the sulfidation at 1025 and 1200°C of Fe alloys containing La or Ce takes place according to: R (in Fe) + $S_2(g) \rightarrow RS_2$, where R = La or Ce. Microscopic examination of the polished sections of sulfidized samples showed that the color of the sulfide inclusions was black. It was concluded that it is not possible to convert Ce and La oxide (R_2O_3) to sulfide (RS_2) under the experimental conditions used. In a few selected cases the oxygen content of a sulfidized sample was determined and compared with the concentration of oxygen present in the original, unsulfidized sample. In each case the final sulfur contents were found to be essentially the same as the original oxygen concentrations in these alloys. (P.C.H.)

632 TRANSPIRATION APPARATUS FOR DETERMINING VAPOR PRESSURES OF METAL OXIDES. Becker, Aaron Jay. Chicago; Illinois Inst. of Tech. (1971). 101p. University Microfilms Order No. 72-22,834.

Thesis.

A transpiration apparatus is described which was constructed in order to determine the total vapor pressure and the partial pressure of oxygen in equilibrium with binary metal oxides that contain plutonium. Several parts of the apparatus were placed in a glovebox to minimize the hazards in handling plutonium. The pressure of oxygen is sufficiently small that it is necessary to use mixtures of gases as carrier gases in which the pressure of oxygen is calculated. Such mixtures may be one of the three: H_2O-H_2, CO_2-CO or O_2–Ar. Experiments are performed by recirculating the carrier gases over the solid oxide until the composition of the gas is observed to be constant. The pressures of oxygen in the carrier gas determines the composition of the solid metal oxide. A different gas analyzer was provided for each of the mixtures. The pressure ratios in the carrier gas and the temperature of the sample are used to calculate the partial pressures of oxygen. Samples of the solid oxide are suspended on a balance and the mass data are employed to calculate the sum of the partial pressures of metal-bearing species. The composition of the sample is determined by using an on-line gravimetric procedure. Metal oxides, whose partial pressures of oxygen range from 0.2 atmospheres through 10^{-16} atmospheres or lower, may be studied with the apparatus. Temperatures of samples can be adjusted from 1000 to 3000°K. The apparatus was tested by measuring the partial pressures of oxygen in equilibrium with nonstoichiometric uranium dioxide, UO_{2-x}, at 2109 and 1942°K. The carrier gas used was H_2O-H_2. The solid phase was analyzed for the composition after the experiment by oxidizing it to $UO_{2.000}$. The oxidations were carried out at 1550°K in atmospheres that contained 100 to 1000 parts per million water vapor. The analyses were done without removing the samples. Values of log p(O) ranged from −9.8 to −12.4. The precision of the measurement of temperature was ±3°K. The precision in log p(O) was ±2% and the precision in the O/M ratio was ±0.002. The partial pressures of oxygen obtained in the present work agreed with published data on UO_{2-x}. It was concluded that the apparatus worked properly. As a supplement to the work, a method of using transpiration data for the determination of the equilibrium constant for a gaseous reaction was developed. The method makes it possible to calculate the partial pressures of the individual metal-bearing species that are in equilibrium with a binary nonstoichiometric metal oxide. The compound, UO_{2-x}, was employed to illustrate the technique. A working equation containing the total pressure and the partial pressure of oxygen was derived by employing the Gibbs–Duhem equations and the criteria of chemical equilibria. The mole fractions of species in the gas phase are parameters in the working equation. The mole fractions of UO_2 and UO in the gas were determined. The results of the calculations made it possible to obtain equilibrium constants at 2080, 2185, 2290, 2390, 2495, 2600, and 2705°K, for the reaction $UO_2 = UO + O$. The standard enthalpy of reaction was obtained from the slope of the curve obtained by plotting the logarithm of the equilibrium constant against the reciprocal of the temperature. The value obtained was 175.1 kcal/mole compared to 173.8 kcal/mole calculated from other experimental data. (Diss. Abstr. Int., B)

633 PHASE RATIOS IN THE SYSTEMS Sm_2O–CaO AND Gd_2O_3–CaO. Lopato, L. M.; Gerasimyuk, G. I.; Shevchenko, O. V.; Tresvyatskii, S. G. (Inst. Problems of Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 7, 635-8(Jul 1972). (In Ukrainian).

Phase diagrams of the systems Sm_2O_3–CaO and Gd_2O_3–CaO are plotted by the method of annealing and hardening by means of high-temperature, x-ray and differential thermal analyses. The presence of the compounds $CaLn_4O_7$, formation of solid solutions on the base of initial oxides, temperature drop of polymorphic transformations of rare-earth element oxides with different CaO dissolving are established. (auth)

634 APPLICATION OF LINEAR ANALYSIS TO STUDY OF POROSITY OF CERAMIC NUCLEAR FUEL MATERIALS. Landspersky, Hanus (Inst. of Nuclear Research, Rez, Czech.). Jad. Energ.; 18: No. 8, 278-9(Aug 1972). (In Czech).

Automatic instruments employed in stereometric microscopy were used to measure the linear dimensions of pores along an arbitrary straight line, in order to evaluate ceramic fuel materials. The distribution function of the intervals could be expressed by analytical formulas, involving polynomes, $n = S_i 6$.

The derived formulas made it possible to determine the distribution function of pore diameters and volumes from exact mathematical equations. UO_2-based ceramic material was used as the example to illustrate the application of the method. (TTT)

635 RELATIONSHIP BETWEEN THE ELECTRICAL RESISTIVITY AND SOLUTE CONCENTRATION IN THE SOLID SOLUTION OF TANTALUM–HYDROGEN SYSTEM. Garcia, Eduardo A. (Comision Nacional de Energia Atomica, Buenos Aires). Z. Metallk.; 63: No. 9, 561-3(Sep 1972).

It was found that the electrical resistivity change produced in Ta when hydrogen is absorbed in the range of the α-solid solution between 0.1 to 0.3 H/Ta at 400°C and 0.05 to 0.4 H/Ta at 190°C, is linearly proportional to solute concentration. The proportionally constant K_M, has a value of $62.4 \pm 0.5\ \mu\Omega$ cm/(H/Ta), which is independent of temperature. (auth)

636 THERMODYNAMIC TREATMENT OF THE HIGH-TEMPERATURE OXIDATION IN TUNGSTEN AND MOLYBDENUM. Neumann, G. M.; Mueller, U. (OSRAM-Studiengesellschaft, Munich). Metall; 26: No. 8, 806-11(Aug 1972). (In German).

By means of a computer program, the composition of the gaseous phases was calculated for the heterogeneous tungsten–oxygen, molybdenum–oxygen, and tungsten–molybdenum–oxygen systems. The calculations were performed within the temperature range from 1000 to 3600°K and within the oxygen pressure range from 10^{-1} to 10^{-6} atmospheres. Results showed that at temperatures below 1500 to 1900°K, solid metal oxides were present in addition to solid metals. Only solid tungsten oxides occurred in mixed systems. In higher temperature ranges of open systems, tungsten migrated chemically from cold to hot; at extremely high temperatures, the migration direction was reversed. In sharp contrast, molybdenum transport always proceeded from hot to cold. (tr-auth)

637 MANUFACTURE OF FUEL ELEMENTS IN THE NETHERLANDS. Bonsel, W. G. Atoomenergie Haar Toepass.; 14: 216-20(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

A survey is given of the activities in fuel element fabrication in the Netherlands: how big is the potential market for fuel elements in the Netherlands, which activities have been carried out in the previous years, which trends could be observed in 1970–1971, and what is the present situation? (auth) (Netherlands)

638 INTERACTION IN THE Y_2O_3–Al_2O_3 SYSTEM. Kniga, M. V.; Mikhaleva, T. G.; Rivkin, M. N. (Belorussian State Univ., Minsk). Zh. Neorg. Khim.; 17: No. 6, 1744-6(Jun 1972). (In Russian).

A reaction between Y_2O_3 and Al_2O_3 was not observed to occur at ratios of 3 : 5 or 1 : 1 at temperatures 900 to 1,200°C, as judged by phase, chemical, x-ray, or infrared analyses. A reaction did take place upon the decomposition of the nitrate salts. Aluminates were produced between 900 and 1,000°C, the reaction going to completion at 1,100 to 1,200°C. (tr-auth)

639 ADSORPTION CAPACITY OF HIGHER AND LOWER OXIDES OF Y, U, AND Mn PRODUCED BY MUTUAL CONVERSIONS. Mardaleyshvili, R. E.; Daneliya, A. P.; Kon, M. Ya. Vestn. Mosk. Univ., Ser. II. Khim.; 12: No. 4, 387-97(1971). (In Russian).

The change in the surface of oxides of vanadium (V_2O_5, V_2O_4, and V_2O_3), uranium (UO_3, U_3O_8, and UO_2) and manganese (MnO_2, Mn_3O_4, and MnO) during mutual adsorption-reversible redox conversions of the oxides was studied by the method of adsorption of N_2, H_2, Ar, NH_3, O_2 $(C_2H_5)_2O$ and CO from the gas phase. It is shown that during these conversions, the absolute quantity of Me and O adsorption centers and their relationships are changed, while the share of surface atoms in relationship to the total number of atoms in the adsorbent does not change. The Me/O ratio appears to be identical on the surface and in the volume of stoichiometric oxides. It is suggested that the degree of development of the surface be characterized by the ratio of the number of surface atoms, determined by the adsorption method, to the total number of atoms in the specimen of adsorbent. (JPRS)

640 IMPORTANCE OF THE POWDER FLOW RATES IN PLASMA SPRAYING. Hantzsche, Helmut. Schweisstechnik (Berlin); 21: No. 9, 399-403(Sep 1971). (In German).

Owing to the difficulty of producing wire of WC or ZrO_2, it is usual practice to use these and other similar materials in the form of powder in plasma spraying. The requirements of powder [flux] for plasma arc spraying with regard to flowability, grain size, etc., are outlined and the relationships between the various parameters in plasma spraying studied. The effects of these parameters, flux feed rate, trajectory, spray speed, and angle of emergence on the bonding, appearance, and properties of the deposited layer, are discussed. The determination of the flux speed, 7 to 9 m/s, from the powder tube dia and the jet dia (of the plasma spray gun) is mentioned. Micrographs of WC layers sprayed using various powder tube dia and flux speeds are shown. (Metals Abstr.)

641 SELF-DIFFUSION OF CARBON IN URANIUM MONOCARBIDE. Makino, Y.; Asahi, K.; Son, P.; Miyake, M.; Sano, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 10, 569-73 (Oct 1972).

The diffusion of C in UC has been measured using radioactive tracer and sectioning technique. Self-diffusion coefficients of C in UC are described well by the equation $D = 4.7 \times 10^{-2} \exp [-(54.7 \pm 2.8/RT)\text{kcal/mole}]\ \text{cm}^2/\text{sec}$ over the temperature range of 1,400 ~ 2,000°C. (auth)

642 TEMPERATURE DEPENDENCE OF THE STRENGTH OF HARD ALLOYS DURING BENDING. Platov, A. B. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov, No. 10, 68-74(1970). (In Russian).

The problem of testing hard alloys at elevated temperatures is considered. The temperature dependence of the strength in pure and transverse bending of a number of industrial hard alloys was obtained. Temperature inflections in the temperature/strength curves for low-Co alloys of the VK[WC–Co] type and for alloys of the Ti group exist in the 600 to 700°C region and for high-Co alloys of the VK type in the 350 to 400°C region. (Referativnyi Zh.)

643 SOME PHYSICO-MECHANICAL PROPERTIES OF SOLID SOLUTIONS OF (TITANIUM, TUNGSTEN) CARBIDE HAVING VARIOUS CONTENTS OF BOUND CARBON. Chaporova, I. N.; Rybal'chenko, R. V. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov; No. 10, 93-100(1970). (In Russian).

Experimental data are given for the dependence of elastic modulus, specific electric resistance, coefficient of linear expansion, microhardness, and hardness at elevated temperature on the phase composition and content of bound C. Specimens tested were of solid solution (Ti, W)C having TiC : WC of 50 : 50 at.%. Bound C contents in its homogeneous region had no significant effect on the physical and mechanical properties. There was a reduction in these properties on transition to the two-phase (Ti, W)C + W or (Ti, W)C + C regions. The resistivity changed along a curve that had a maximum at the solid solution composition $(Ti, W)C_{0.85}$. (Referativnyi Zh.)

644 METHOD FOR THE ANALYSIS OF DEFORMATION AND STRESS DISTRIBUTION BETWEEN PHASES DURING THE DEFORMATION OF TUNGSTEN CARBIDE–COBALT ALLOYS. Klochko, N. A. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov; No. 10, 44-54(1970). (In Russian).

A study was made on the stresses in the Co and WC phases of WC–Co alloys that arise during cooling after sintering and on the changes that occur in these stresses during external loading. The stresses in the Co phase caused by cooling were almost independent of the Co content of the alloy whereas those in the WC phase are almost proportional to the Co content. A calculation for determining the stresses in the phases due to external loading is given; results were in good agreement with experimental values. (Referativnyi Zh.)

645 EFFECT OF ADDITIONS OF TANTALUM AND ITS METHOD OF INTRODUCTION, ON THE STRUCTURE AND SOME PROPERTIES OF THE TWO-PHASE (TITANIUM, TUNGSTEN) CARBIDE–COBALT ALLOYS. Cheburaeva, R. F.; Chaporova, I. N. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov; No. 10, 79-87(1970). (In Russian).

A study was made on the effects of the quantity and method of introduction of Ta (0 to 10 mole %) on the microstructure and certain properties of the two-phase alloys (Ti, W)C–Co containing Co 6 and 15 wt. %. With a constant TiC : WC ratio of 32 : 68 the introduction of TaC, within the concentration range studied, either as a solid solution (Ti, W, Ta)C or as TaC directly into a (Ti, W)C + Co mixture, has no noticeable effect on the microstructure or the composition of the (Ti, W, Ta)C solid solution. The method of TaC introduction did affect the UTS during bending and the hardness at room temperature of alloys with a relatively high content of the binding phase, i.e., Co 15 wt. %. The amount of added Ta had differing effects on the physical and mechanical properties of the (Ti, W)C–Co alloys. (Referativnyi Zh.)

646 PREPARATION OF HIGH-DENSITY URANIUM NITRIDE AND URANIUM CARBONITRIDE FUEL PELLETS. Oi, Noboru; Hirayama, Satoru; Tanabe, Isami; Muramatsu, Akikazu; Kawada,

Toshiyuki (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 521-7(Sep 1972).

Uranium nitride and uranium carbonitride fuel pellets were prepared for irradiation in the Japan Material Testing Reactor. The pellets are 6.9 mm in diameter and 7 mm long and are of natural and 5% enriched uranium. Uranium nitride powder was prepared from uranium metal via hydride and higher nitride. Uranium carbide powder was prepared from uranium metal by hydriding and then reacting with propane. The lowest possible reaction temperatures were selected to obtain fine and reactive powders. Uranium nitride and mixed powders of different ratios (UC : UN = 1 : 3, 1 : 1 and 3 : 1) were cold pressed without binder. Sintering was carried out in a tungsten crucible in vacuum (10^{-4} mm Hg) for 2 h at 1,900° ~ 2,000°C. The density of the pellets obtained was in the range of 90 ~ 95% of the theoretical value with an oxygen content of 1,300 ~ 2,100 ppM. No second phase, such as metallic uranium, was observed in the specimens, either by metallography or x-ray diffraction. These pellets of unexpectedly high density without second phase must have been obtained thanks to the good powder characteristics combined with proper sintering conditions. The compositions of uranium carbonitride pellets were found to be slightly nitrogen deficient, compared with the reactants. (auth)

647 EFFECT OF TANTALUM CARBIDE ON THE STATIC AND CYCLIC STRENGTH AND DEFORMATION DURING COMPRESSION OF THE TUNGSTEN CARBIDE–TITANIUM CARBIDE–COBALT THREE-PHASE ALLOYS. Tumanov, V. I.; Kreimer, G. S.; Bragilevskii, V. L.; Bogino, E. M. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov, No. 10, 74-9(1970). (In Russian).

The strength and deformation properties of WC–TiC–Co three-phase alloys containing Co 8 and 20% were determined in relation to the effects of TaC additions. Properties were determined in static compression and in cyclic impact compression tests. The differing effects of TaC on the UTS, YS, and ductility were explained by changes in the chemical composition of the Co solid solution and its ductility. The introduction of TaC into the Co 8% alloy increased the impact fatigue life during compression as compared with the Ta-free alloys, i.e., for the alloy containing TaC 48 mol. % (of total carbides) by 6 times and for the alloy containing TaC 7.5 mol % by 25 times. (Referativnyi Zh.)

648 SUPERPLASTICITY OF REFRACTORY COMPOUNDS. Andrievskii, R. A.; Spivak, I. I.; Klimenko, V. V. Dokl. Akad. Nauk SSSR; 203: No. 6, 1279-81(1972). (In Russian).

The phenomenon of superplasticity in the two-phase compositions VC–ZrC, VC–HfC, and TiC–ZrC was investigated. The samples were prepared by hot pressing and annealing at 2500°C and had a porosity of from 1.5 to 15%. When creep rates were plotted as a function of the composition, pronounced maxima were observed, particularly with the compositions VC–ZrC and TiC–ZrC. In the case of VC–ZrC, the maximum coincided with the eutectic composition. (K.S.W.)

649 CONTRIBUTIONS TO THE CHEMISTRY OF MOLYBDENUM AND TUNGSTEN. IX. SOME ASPECTS OF THE STRUCTURE OF WO_3 AND A CONTRIBUTION TO THE UNDERSTANDING OF THE SO-CALLED "SHEAR STRUCTURES". Schroeder, F. A. (Univ., Freiburg i. B.). Z. Naturforsch.; 27b: No. 8, 902-8 (Aug 1972).

By using the Periodic Bond Chain Vector method, a newly prepared combination of forms of highly stoichiometric WO_3 is discussed. Through the consideration of the features of the structure it can be explained why the observed faces are built. From characteristics of the structure an improved understanding of the origin of so-called shear structures of the ReO_3-type family could be derived. (auth)

650 NITRIDE LAYER GROWTHS ON LIQUID THORIUM AND ON SOLID THORIUM CARBON ALLOYS. Benz, R. (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc.; 119: No. 11, 1596-1602(Nov 1972).

Nitride layers were formed on thorium-carbon alloys by reaction with nitrogen (1 to 1600 torr) at temperatures between 1400 and 2400°C. Values of scale thicknesses of face-centered cubic (fcc) ThN on liquid thorium and of Th(C,N) on solid alloys with C/Th = 0.10, 0.20, and 0.30 were found to be proportional to the square-root of time of reaction indicating growth rates are controlled by diffusion. Calculated composition-average values of concentration-gradient type interdiffusion coefficients in pure ThN at 1900, 2100, and 2400°C can be represented by the equation $\tilde{D} = 254 \exp(-99.4 \pm 30 \text{ kcal/mole})/RT$. Diffusion coefficients in the Th(C,N) layers are approximated by the same method: cross effects due to presence of carbon are neglected. The results show that the nitrogen diffusion rate in Th(C,N) increases with carbon content and with decreasing nitrogen pressure. Nitrogen-rich Th(C,N) layers formed on alloys with C/Th ratio ≥ 0.4 are preceded by a carbon-rich front containing ThC_2 precipitate. This observation together with the assumption of negligible mobility of thorium atoms leads to the conclusion that carbon diffuses "uphill" against a concentration gradient. The phenomena also occurs in the analogous U(C,N) phase during reaction under similar conditions. With increasing carbon content, nitrogen diffusion is suggested to change from a vacancy mechanism in pure ThN to a substitution mechanism in carbon-rich Th(C,N). (auth)

651 DIFFUSION OF BORON FROM SHALLOW ION IMPLANTS IN SILICON. Wagner, S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc.; 119: No. 11, 1570-6(Nov 1972).

The use of shallow ion implants as diffusion sources was studied on bare (111) silicon wafers implanted at room temperature with 30 keV, 3×10^{14} cm^{-2} boron. Samples were annealed in purified argon at 900, 1000, and 1100°C. The diffusion profiles of boron are determined by in-diffusion into the silicon and by dissolution, to equilibrium, in the thin oxide layer on the surface. The amount of boron retained in silicon decreases during the initial period of an anneal and then remains constant. More boron is retained the higher the temperature and the lower the oxygen content in the ambient gas. With ~10 ppM O_2 in argon, losses range from 15 to 35% of the implanted dose. Experimental results are reasonably well represented by the mathematical formalism developed. The experimental data indicate that the values listed in the literature for sheet conductivity mobilities of holes are too low. (auth)

652 OXIDATION STATE OF ANODIC TANTALUM OXIDE AFTER HEAT-TREATMENT. I. GALVANOSTATIC METHOD AS APPLIED AFTER HEATING IN VACUUM. Klein, G. P. (P. R. Mallory and Co. Inc., Burlington, Mass.). J. Electrochem. Soc.; 119: No. 11, 1551-60(Nov 1972).

During heat-treatment of anodic Ta_2O_5 in vacuum (10^{-5} torr) at temperatures in the range from 200 to 700°C oxygen exchange between the anodic oxide, the Ta substrate, and the atmosphere was observed. Galvanostatic reanodization experiments resulted in potential-time (charge) curves which could be used to determine the oxidation state of heat-treated TaO_n as a function of the distance from the electrolyte/oxide interface into the oxide. Profiles of the oxidation state across the oxide were measured for tantalum oxide anodized in 0.1M H_3PO_4 and 0.1M H_2SO_4 after heat-treatment at 10^{-5} torr and 500°C. Of several experimental variables, the time of heat-treatment and the oxide thickness were chosen to illustrate the method of determining oxidation state profiles for the case of heat-treatment in vacuum. In all cases discussed the reduction was carried out to the extent that the oxide as a whole exhibited high electronic conductivity. (auth)

653 ELECTRON INJECTION INTO ANODIC VALVE METAL OXIDES. II. FURTHER EXPERIMENTAL RESULTS FOR Ta_2O_5, Nb_2O_5, AND Al_2O_3. Jaeger, N. I.; Klein, G. P.; Myrvaagnes, B. (P. R. Mallory and Co., Inc., Burlington, Mass.). J. Electrochem. Soc.; 119: No. 11, 1531-8(Nov 1972).

Electron injecting contacts can be formed at valve metal oxide/semiconducting metal oxide interfaces with applied fields of the order of some 10^6 V/cm. Electronic current injection as a function of time and applied field (activation) has been measured for Ta/Ta_2O_5, Nb/Nb_2O_5, and Al/Al_2O_3 electrodes in contact with Fe_2O_3 as the semiconducting transition metal oxide. The activation process is explained on the basis of interacting ionic and electronic processes with the ionic charge transport following the empirical field law for anodic oxide growth $i = A \exp(BF)$. The explicit dependence of the electronic process on parameters of the ionic conduction process has been confirmed by determining the ionic conduction parameters from the field and temperature dependence of the activation process. Quantitative agreement with values reported from measurements of the kinetics of anodic oxide growth has been obtained. The electronic current resulting from activation of $Nb/Nb_2O_5/Fe_2O_3$ and $Ta/Ta_2O_5/Fe_2O_3$ electrodes in contact with electrolytes showed a field dependence typical for thermionic emission. Linear log i vs. $F^{1/4}$ characteristics could be obtained extending over 4–5 decades with slopes in agreement with thermionic emission following a Poole–Frenkel mechanism. It appears that valve metal/valve metal oxide/semiconducting oxide electrodes with two oxides in intimate but initially blocking contact provide model systems for the generation of coulombic centers from which thermally activated electron emission with Poole–Frenkel characteristic can take place. The barrier height for the thermionic emission process and its change with progressing activation has been determined from measurements of the temperature dependence of the electronic current with applied field

and state of activation as parameters. The barrier heights were found to be of the order of 1 eV. (auth)

654 THERMODYNAMIC ACTIVITY OF Na_2O–B_2O_3 MELT. USE OF STABILIZED ZIRCONIA AS AN ELECTRODE CONSTITUENT. Sato, Seichi; Yokokawa, Toshio; Kita, Hideaki; Niwa, Kichizo (Hokkaido Univ., Sapporo). J. Electrochem. Soc.; 119: No. 11, 1524-6(Nov 1972).

The thermodynamic activity of Na_2O in $Na_2O-B_2O_3$ melts was measured using CaO stabilized ZrO_2 solid electrodes. The characteristics of the electrode are discussed. (J.R.D.)

655 TWINNING OF BORON NITRIDE. Alekseev, Yu. A.; Nikitina, T. P.; Filonenko, N. E. (All-Union Scientific-Research Inst. of Abrasives and Grinding, Leningrad). Dokl. Akad. Nauk SSSR; 203: No. 5, 1051-3(11 Apr 1972). (In Russian).

Microscopic and goniometric investigations of isometric crystals of boron nitride were conducted. Ordinary flattened twinning and three manifestitations of twinning according to the spinel rule were studied. The discussion pertains to vicinal forms associated with twinned platelets and twinned lamellae, angles between faces, and the connection between the phenomenon of twinning and the modification conversion α-BN → β-BN. (K.S.W.)

656 MICRO-SEGREGATION AND EUTECTIC CARBIDE PRECIPITATION IN IRON–CARBON–TUNGSTEN ALLOYS. Hoffmeister, Hans; Schuermann, Eberhard (Technische Univ., Clausthal-Zellerfeld, Ger.). Arch. Eisenhuettenw.; 43: No. 6, 449-56(Jun 1972). (In German).

Investigations were made on the microsegregation and precipitation of primary carbides of iron–carbon–tungsten alloys containing 0.5 to 2.2% C and 1.0 to 12.4% W as well as <0.35% Si, <0.55% Mn, <0.03% P, and <0.04% S. Information regarding the crystal segregation of tungsten as dependent on the total content of carbon up to the attainment of carbide saturation of the mixed crystals was obtained. The relationship between the amount of primary carbides and increasing total amounts of carbon at constant tungsten content was found. The proportions of the two carbides M_6C and M_3C were determined along with the effects of homogenization on the elimination of microsegregation and precipitation of carbides rich in tungsten. (auth)

657 UO_2 PROPERTIES AFFECTING PERFORMANCE. Lyons, M. F.; Boyle, R. F.; Davies, J. H.; Hazel, V. E.; Rowland, T. C. (General Electric Co., San Jose, Calif.). Nucl. Eng. Des.; 21: No. 2, 167-99(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

UO_2 has become the basic reference fuel material for the power reactor industry. The most widely used form is cylindrical, sintered pellets with finished densities in the range 92 to 97% of theoretical. This selection of UO_2 over other potential fuel materials is based on its excellent combination of chemical stability, especially to water reactor coolants; compatibility with potential cladding materials such as stainless steel and zircaloy; dimensional stability under irradiation; very high melting point; and straightforward, economical production from diffusion plant enriched, uranium hexafluoride. These desirable characteristics were recognized at a very early stage in the development of power reactors, and, as a result, the properties of UO_2 have been under intensive study for about 20 years. There has probably been more development work on UO_2 than all other fuel materials combined. The data cited are those most familiar that are believed to fairly represent a property or illustrate the relationship under consideration. The basic UO_2 property data are presented and the effects of important variables such as density, temperature, stoichiometry, etc., are discussed. In the second part the property data are discussed in the context of their role in various fuel life-limiting mechanisms that have been shown to be of practical significance for UO_2-containing fuel rods. (120 references). (auth)

658 MECHANICAL INTERACTION BETWEEN FUEL AND CLADDING. Aas, Steinar (Institutt for Atomenergi, Kjeller, Norway). Nucl. Eng. Des.; 21: No. 2, 237-53(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

Because UO_2 expands more than the Zircaloy cladding tube, is hotter, cracks, and swells, the UO_2 will interact with the cladding. How much is dependent upon the gap, length of pellet, whether it has flat ends or not, the depth of the dish, the width of the shoulder, heat load, rate of power increase, and cladding properties. The stress–strain pattern can be very complicated. It usually has a changing multiaxiality with consequent varying strains to fracture, and the strains may be concentrated over small lengths of the cladding tube. All this adds up to a threat to the integrity of the Zircaloy, particularly since the properties of this material are so adversely affected by irradiation. To avoid difficulties and failure, the pellet shape, dimensions and density, and cladding properties should be chosen with due regard to reactor system conditions, the way the reactor is loaded and operated. The ideal cladding should have good ductility and high strength at the same time. Such a combination seems impossible, unfortunately. Many of the processes described are known only qualitatively, therefore there is a definite need for many more precisely defined and executed experiments, preferably in-pile. (auth)

659 SOME PHENOMENA OBSERVED DURING SINTERING OF METAL-CARBIDE SYSTEMS IN SOLID STATE. Selpcov, V. M.; Petrova, E. M.; Shcherban, N. I. (Inst. for Materials Development, Kiev). Phys. Sintering; 4: No. 3, 165-79(Sep 1972).

A study of the kinetics of the diffusion layer growth during interaction of Ti, Zr, Nb, Cr, Mo, and W carbides with cobalt showed reaction diffusion at raised temperatures, dependent on their thermodynamic stability. Shrinkage during sintering of green compacts with a relative density of 0.55 to 0.8 had a practically linear shape. Axial and radial shrinkage ratios were a linear function of composition. Equations are suggested to simplify examination of the concentration dependence of shrinkage in two-component materials, this dependence being determined by the diffusion rate. (auth)

660 THERMODYNAMIC STABILITY IN Cu–Me–O SYSTEMS (Me = Ge, Ga, Ti, OR Nb). Slobodyanyuk, A. A.; Tret'yakov, Yu. D.; Bessonov, A. F. (Sevastopol Instrument Construction Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 18-21 (1972). (In Russian).

Galvanic cells were prepared with Pt metal in contact with an oxide combination as the anode, working against oxygen gas as the cathode (air, partial pressure of O_2 = 0.21 atm). The various oxide combinations were prepared from powdered TiO_2, Ga_2O_3, GeO_2, or Nb_2O_5, by mixing one of these oxides with copper oxide and firing at 950°C for 6 hr in a vacuum. The resulting salts formed anodes of the test galvanic cells, and represented the system Cu–Me–O, where M = Ti, Ga, Ge, or Nb; e.g., $CuGeO_3$, $CuGa_2O_4$, Cu_3TiO_5, or $CuNbO_3$. The thermodynamic stability of these systems was evaluated from emf measurements on eight such oxide systems at selected temperatures in the range 800 to 1150°C. The results were expressed in the form: $E_{mV} = A - BT$, where A and B were constants for a given oxide system. (K.S.W.)

661 LIQUIDUS DETERMINATIONS IN THE 25 PERCENT SiO_2 PLANE OF THE QUATERNARY SYSTEM CaO–Nb_2O_5–TiO_2–SiO_2. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 29: 349-60(1972).

Liquidus temperatures in the 25% SiO_2 plane of the CaO–Nb_2O_5–TiO_2–SiO_2 phase tetrahedron have been determined using the customary quench technique as well as hot-stage microscopy. The boundaries between the phase fields of CaO · TiO_2, CaO · TiO_2 · SiO_2, TiO_2, SiO_2, CaO · Nb_2O_5, CaO · SiO_2, 10 CaO · Nb_2O_5 · 6 SiO_2 (niocalite) and 2 CaO · SiO_2 have partly been outlined. This 25% SiO_2 plane probably also includes phase fields for 3 CaO · SiO_2 and CaO. A phase field of CaO · SiO_2 is wedged in between those of CaO · Nb_2O_5 and 10 CaO · Nb_2O_5 · 6 SiO_2 (niocalite), instead of a field of 2 CaO · Nb_2O_5, as is found in the 20% SiO_2 plane. This would be expected from the known CaO–Nb_2O_5–SiO_2 phase diagram. All three compounds, 2 CaO · Nb_2O_5, CaO · Nb_2O_5 and 10 CaO · Nb_2O_5 · 6 SiO_2, apparently occupy similar phase volumes between the CaO–Nb_2O_5–SiO_2 side and the large phase volume of CaO · TiO_2 (perovskite), in the quaternary system. A summary of the phase relationships studied in the CaO–Nb_2O_5–TiO_2–SiO_2 system is given, and also some discussion of the mineralogical implications of these studies. (auth)

662 SUPERCONDUCTIVITY AND THE STRUCTURE OF W_2C. Morton, N.; James, B. W.; Wostenholm, G. H.; Hepburn, D. C. B. (Univ. of Salford, Eng.). J. Less-Common Metals; 29: 423-6(1972).

The superconducting critical temperatures of samples of α, β and γ-W_2C and the low temperature orthorhombic phase recently described by Telegus et al. have been determined. The critical temperatures lie within the ranges 3.05 to 3.35, 3.1 to 3.85, 2.85 to 3.05 and 2.4 to 4.05 K, respectively. The critical temperatures of samples of the orthorhombic β and Telegus et al. forms are generally higher than found previously for W_2C. (auth)

663 RELATIVE STABILITIES OF SEVERAL FORMS OF NIOBIUM PENTOXIDE. Kodama, Hiroshi; Kikuchi, Takeshi; Goto, Masaru (National Inst. for Researches in Inorganic Materials, Sakura-Mura, Japan). J. Less-Common Metals; 29: 415-21(1972).

The relative stabilities of so-called T, B, P and H-forms of niobium pentoxide, at 600 and 800°C at one atmosphere, were estimated by the isothermal heating of mixtures of these modifications and also by observations of the thermal decomposition of Nb_3O_7Cl. The relative stabilities were found to increase in the order T → H → P → B at 600°C and T → P → B → H at 800°C. A schematic pressure–temperature phase diagram is proposed on the basis of the experimental results. (auth)

664 TEPLOFIZICHESKIE SVOISTVA TVERDYKH VESHCHESTV. (Thermophysical Properties of Solids). Conference Held at Moscow, October 1968. Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). 184p. (CONF-681091).

Fifty papers were presented at the conference. A separate abstract was prepared for seven of the papers. The remaining 43 papers were not in scope for NSA. (T.F.D.)

For abstracts of individual papers see: 665–668 and 830–832.

665 THERMAL CONDUCTIVITY OF YTTRIUM OXIDE IN THE RANGE 600 TO 2100°K. Chekhovskoi, V. Ya.; Stavrovskii, G. I.; Pustil'nik, A. I.; Sedykh, T. S.; Ivanov, A. B. pp 90-2 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).
From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

Thermal conductivity measurements were conducted on yttrium oxide by the complete cylinder stationary method over the temperature range 350 to 1800°C. Samples were pressed at 500 kg/cm² from powdered oxide with a dispersion of about 20 μ. (tr-auth)

666 THERMAL CONDUCTIVITY OF ZrO_2 COATINGS DEPOSITED BY PLASMA SPUTTERING. Lapshov, V. N.; Bashkatov, A. V. pp 92-6 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).
From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

The coefficient of thermal conductivity of ZrO_2 coatings which had been deposited by plasma sputtering between 30 and 1500°C is given. The dynamic method in air was used in the range 30 to 400°C, the stationary method with electrical heating of two parallel samples was used in the range 300 to 1500°C. (tr-auth)

667 INTEGRAL HEMISPHERICAL EMISSION CAPACITY OF PYROLYTIC CARBIDES OF SILICON AND ZIRCONIUM. Petrov, V. A.; Chekhovskoi, V. Ya.; Sheindlin, A. E.; Dymov, B. K. pp 137-9 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).
From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

The integral hemispherical emissive capability of pyrolytic silicon carbide between 1200 and 2600°K, and that for pyrolytic zirconium carbide between 1200 and 2900°K were determined. Over these two temperature intervals the emissive capability increased from 0.82 to 0.96, and from 0.38 to 0.55, respectively. (tr-auth)

668 THERMODYNAMIC PROPERTIES OF REFRACTORY CARBIDES IN THE HOMOGENEOUS REGION AT HIGH TEMPERATURES. Turchanin, A. G.; Fesenko, V. V. pp 158-63 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).
From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

The enthalpy of the carbides of Ti, Nb, and Zr was determined for 11 different compositions in the region of homogeneity in the temperature interval 1300 to 2500°C. For all specimens tested equations were derived describing the enthalpy, heat capacity, and entropy change as functions of temperature. An intense enthalpy increase for some non-stoichiometric carbides was noted at high temperatures. (tr-auth)

669 DEVELOPMENT OF FUELS FOR HIGH TEMPERATURE REACTORS. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Nippon Genshiryoku Gakkaishi; 14: No. 8, 438-48(Aug 1972). (In Japanese).

The present status of development of fuels for High-Temperature Reactors (HTR) in West Germany is briefly reported. The studies on fuel elements for HTR in KFA (Kernforschungsanlage, Juelich) has been mainly concerned with spherical fuel elements for two pebble bed reactors AVR and THTR. As for the sol-gel procedure to fabricate the fuel kernels for coated particles, particular mention is made of the KFA-H-process, in which the reduction step is not included. Next, the work on the change in the physical and mechanical properties during irradiation, the diffusion behavior of solid fission products and the reduction of gradients of anisotropy and density in PyC-layers are described. Radiation damage in PyC by fast neutrons is also reported. The results of irradiation tests on spherical fuel elements and their performance are described. Finally, the results of investigations on the amoeba effect are reported. (auth)

670 EFFECT OF MOLYBDENUM ON THE PROPERTIES OF SINTERED TiC–Ni HARD ALLOYS. Samsonov, G. V.; Dzodziev, G. T.; Klyachko, L. I.; Vitryanyuk, V. K. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 300-2(Apr 1972).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 57-60(Apr 1972).

Studies were made on the effects of alloying with Mo, over a wide range of concentration, on the structure and physicomechanical properties of TiC–Ni alloys. Metallographic examinations established that the addition of Mo to the binder had a beneficial effect on the structure of the alloys by substantially decreasing the grain size of the carbide phase, the decrease being particularly marked at Mo concentrations in the binder of up to 20 vol %. The results on bend strength of alloys with various amounts of binder showed that, at all binder contents, the highest strength was exhibited by alloys containing about 20 vol. % Mo. At the same time, with rise in binder content, the maximum bend strength of these alloys increased from 105 to 180 kg/mm², reaching approximately the strength level of WC-base alloys. Basically, the same results were found for hardness of the alloys. Test results on cutting wear resistance also showed that at all machining speeds investigated, the life of the TiC–Ni–Mo alloy was much (two to three times) longer than that of WC–15% TIC–6% Co alloy. (P.C.H.)

671 PHASE EQUILIBRIA IN THE SYSTEMS HAFNIUM–NIOBIUM–BORON AND TANTALUM–CHROMIUM–BORON. Kuz'ma, Yu. B.; Telegus, V. S.; Marko, M. A. (Lvov State Univ.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 308-12(Apr 1972).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 66-71(Apr 1972).

In the system Hf–Nb–B, a study was made of 25 specimens whose phase compositions are listed and an isothermal section through the phase diagram of the system at 1400°C was constructed. The isothermal compounds HfB_2 and NbB_2 formed a continuous series of solid solutions (CSSS), the lattice constants and elementary cell volume of which increased as the Nb was replaced by Hf. The compound NbB dissolved up to 20 at. % Hf, the dissolution causing the lattice constants of the solid solution to increase to a = 3.355, b = 8.787, and c = 3.179 Å. The solubility of Hf in Nb_3B_4 did not exceed 5 at. %; the dissolution of Hf in this compound also increased the lattice constants, which, at 5 at. % Hf, 38 at. % Nb, and 57 at. % B, attained the following values: a = 3.313, b = 14.26, and c = 3.095 Å. From x-ray structural analyses of 48 specimens, an isothermal section through the phase diagram of the system Ta–Cr–B at 1400°C was constructed. At this temperature, the compound $TaCr_2$ had a cubic $MgCu_2$-type structure (a = 6.992 Å), while in the unannealed conditions it has a hexagonal $MgZn_2$-type structure. A substantial decrease in the lattice parameters brought about by the dissolution of Cr in Ta_3B_2 and the observed changes in the intensities of interference lines was regarded as indications of a fully ordered distribution of Ta and Cr atoms in a solid solution of composition Ta_2CrB_2. (P.C.H.)

672 HOT PRESSING OF TRANSITION METAL NITRIDES AND THEIR PROPERTIES. Petrykina, R. Ya.; Shvedova, L. K. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 276-9(Apr 1972).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 27-31(Apr 1972).

On the basis of a study of the sintering of transition metal nitride powders by the hot-pressing technique, suitable process parameters were established enabling dense nitride parts to be produced. The energy of activation for viscous flow in hot pressing was determined and found to be much less than the energy of activation for the volume self-diffusion of atoms in the metallic sublattices of the compounds investigated. Using hot-pressed specimens, measurements were made of the electrical resistivities and Hall coefficients of the nitrides. The electr.c conductivity of nitrides of the transition metals of Groups IV-V has a metallic character; the effective current carrier concentration, calculated on the basis of the single-band model, is of the order of 10^{23} cm^{-3}. The experimental data obtained on the physical properties of the nitrides showed that hot-pressing densification yields practically nonporous materials that are identical in properties with the bulk nitrides. (auth)

673 PREPARATION AND SOME PROPERTIES OF SINTERED MATERIALS OF THE SYSTEM AlN–Al_2O_3–Mo. Garibyan,

F. S. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 290-3(Apr 1972).
Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 44-8(Apr 1972).

Suitable conditions were established for the preparation of materials of the system AlN–Al_2O_3–Mo. It was found that the best results were obtained when sintering is performed for 1 h in a nitrogen atmosphere at 1950°C, using calcined alumina packing material. The resultant specimen porosity is 6 to 12%. A study was made of the microstructure, microhardness, and hardness of the composite material obtained. It was demonstrated that, with rise in aluminum nitride content, the hardness and microhardness fell. (auth)

674 METHOD FOR HEATING HYDROGEN GAS. Grosse, Aristid V. (to Reynolds Metals Co.). U. S. Patent 3,682,775. 8 Aug 1972. Filed 11 Oct 1968.

To reduce degradation of refractory carbides exposed at high temperatures to hydrogen gas, such as in a furnace or nuclear reactor environment, a hydrocarbon which is gaseous at that temperature is admixed with the hydrogen. Suitable hydrocarbons include methane, ethylene, and acetylene. (Official Gazette)

Metals and Alloys

Refer also to abstract 96.

675 USAEC HEAVY SECTION STEEL TECHNOLOGY PROGRAM: OBJECTIVES AND STATUS. Witt, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.; 20: No. 1, 169-80(1972).
From 1. international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

The Heavy Section Steel Technology (HSST) program is concerned with the primary vessels for water reactors with the main thrust being placed on the effects of flaws, material inhomogeneities and discontinuities on the behavior of the vessels under normal operating and accident conditions. Emphasis is placed on developing a technology that can be used to establish the margin of safety against failure of the vessels, particularly catastrophic vessel failure beyond the control of plant safety features. Fracture phenomena under the environmental conditions of interest and the effects of section thickness on the fracture behavior of the large reactor vessels are being examined through a systematic progression of specimen sizes up to the equivalent of a full section thickness of 12 in. The program will culminate in a series of simulated service tests in which deliberately flawed vessels of substantial thickness will be tested to fracture. The status of the various investigations is presented and the significant accomplishments in each of the areas of investigation are summarized. (auth)

676 GERMAN IMPORT AND EXPORT OF NUCLEAR FUEL MATERIAL IN 1971. Atomwirt., Atomtech.; 17: No. 9-10, 502(1972). (In German).

Import and export of nuclear fuel material for the year 1971 is compiled in four tables. The figures are broken down as to irradiated and non-irradiated material, as to countries, as to the degree of uranium enrichment, and as to type of nuclear fuel. The import of non-irradiated material approximately doubled because of strong increases in natural uranium from France and in enriched uranium from the USA. The import of irradiated material remained insignificant. The export of non-irradiated fuel material was lower than that in 1970. The export of irradiated material increased slightly. (H.B.G.)

Corrosion and Erosion

Refer also to abstract 1986.

677 (RFP–1945) EFFECT OF RADIATION ON PLUTONIUM CORROSION IN ORGANIC SOLVENTS. Kazanjian, A. R.; Horrell, D. R. (Dow Chemical Co., Golden Colo. Rocky Flats Div.). 6 Oct 1972. Contract AT(29-1)-1106. 4p. Dep. NTIS.

Corrosion tests were made on plutonium metal in contact with carbon tetrachloride, trichloroethylene, chloroform, perchloroethylene, 1,1,2-trichlorotrifluoroethane, hexane, and Texaco Regal A oil. These tests were made under irradiation and nonirradiation conditions to determine whether radiation would enhance the corrosion rate. Enhancement did occur in chloroform and in hexane. The major radiation products, hydrogen chloride in chloroform and hydrogen in hexane, are able to readily react with plutonium. (auth)

678 (SC-DR-710903) CALCULATION OF GAS CONSUMPTION DURING THE INITIAL STAGES OF GAS–METAL REACTION. Sallach, R. A. (Sandia Labs., Albuquerque, N. Mex.). May 1972. 11p. Dep. NTIS.

An analytical expression for the consumption of gas in a gas–metal reaction was obtained for the transition period between regimes where linear and parabolic kinetic laws are obeyed. In the linear regime the reaction is presumed to be limited by the flux of arriving gas at the gas–metal interface, while in the transition period and parabolic regime, the reaction is limited by diffusional processes occurring in the metal phase. The mass gain versus time for the reaction of nitrogen with zirconium is given as an example. (auth)

679 (SC-RR-720614) SCANDIUM OXIDATION STUDIES. Sallach, R. A.; Boultinghouse, K. D. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 12p. Dep. NTIS.

The oxidation of Sc was followed gravimetrically between 300 and 600°C at 50 torr O_2 pressure. Parabolic kinetics were found with an activation enthalpy of ~22 kcal/mole. Oxidations were also made at 250°C in 125 torr O_2 and 625 torr air for comparison with ellipsometry data. In both cases, an approximately cubic rate law was followed with air oxidation about 2.5 times faster than that in pure O_2. The amount of mass uptake was greater than predicted from ellipsometer results. (auth)

680 BEHAVIOUR OF ZIRCONIUM ALLOYS IN ORGANIC COOLANTS. Boulton, J. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Can. Met. Quart.; 11: No. 1, 1-5(1972). (AECL-4239).
From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The corrosion and hydriding behavior of zirconium alloys in organic coolants is reviewed. Provided careful control of coolant chemistry is maintained, zirconium alloys can be satisfactorily used as fuel cladding and coolant tube materials in an organic-cooled reactor. Two alloys, Zr–2.5 wt% Nb and Ozhennite 0.5 show the best promise and their performance, in service in WR-1, is being evaluated. (auth) (Canada)

681 SOME OBSERVATIONS ON IN-FLUX CORROSION OF ZIRCONIUM ALLOYS EXPOSED IN A PRESSURIZED WATER LOOP. Van der Linde, A. (Reactor Centrum Nederland, Petten). Can. Met. Quart.; 11: No. 1, 7-19(1972).
From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Zirconium alloy specimens were exposed for 76 and 110 days in an in-reactor pressurized water loop at 275°C, a water pressure of 140 kg/cm^2 and a flow rate of 3.3 m/sec. The main water chemistry conditions were 0.2 to 0.6 ppM oxygen and pH 8.5 with ammonia. The fast neutron flux ranged from 1 to 45.10^{12} n/cm^2 · sec (>1 MeV). In the as-etched condition the Zircaloy-2 and Zircaloy-4 oxidation was faster at the higher flux levels while the Zr–2.5 Nb and Zr–3 Nb–1 Sn oxidation was not significantly influenced by the flux level. Zircaloy-2 and Zircaloy-4 specimens, oxidized prior to in-reactor exposure in an out-of-reactor pressurized water loop up to weight gains of 28 to 150 mg/dm^2, showed in-flux enhancements in the weight gains which were highly dependent on the fast neutron fluence. The as-etched specimens showed shiny black oxide films but the oxide film on the pre-oxidized specimens contained pustules. Pustule formation was promoted by the fast flux and by local coolant flow disturbances. In-flux induced formation of an iron-chromium phase in the Zircaloy base metal could not be correlated to the appearance of the oxide pustules. On the zirconia-based recrystallization-pore generation mechanism the phenomena observed are explained qualitatively. (auth) (Canada)

682 ZIRCONIUM ALLOYS FOR USE IN STEAM BETWEEN 400° AND 500°C. Demars, H.; Givord, J. P. (Laboratoires de Recherches de Venthon, France). Can. Met. Quart.; 11: No. 1, 27-35(1972). (In French).
From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

A few alloying elements were tested in ternary alloy combinations with zirconium to evaluate their corrosion resistance in steam at elevated temperatures. The alloys, prepared as buttons of approximately 70 grams, were tested in the rolled and annealed condition in steam at 400, 450, and 500°C. Particularly promising results were obtained with the ternary alloys Zr–Fe–V and Zr–Cu–V. The corrosion behavior in steam at temperatures up to 550°C of these two alloy combinations was, therefore, systematically studied. These tests permitted the determination of the optimum compositions as well as the temperature limits of their use. (auth) (Canada)

683 OXIDATION OF VANADIUM ALLOY CLADDING MATERIAL IN CONTACT WITH MIXED OXIDE FUEL. Bober, M.; Dorner, S.; Sari, C.; Schumacher, G. (Kernforschungszentrum,

Karlsruhe, Ger.). Kerntechnik; 14: No. 8, 347-53(Aug 1972). (In German and English).

The oxidation of vanadium alloys in contact with uranium-plutonium mixed oxide fuel was studied. The experiments were carried out with a V–2 Ti–15 Cr alloy at 800 and 1200°C. In order to simulate the thermal conditions in a reactor, the fuel had been exposed to a steep temperature gradient. The results and the calculations showed that a significant oxidation and hardening of the vanadium alloy must be anticipated in the reactor. A protective oxide layer is not formed. Even the use of substoichiometric fuel does not affect this situation fundamentally. The oxygen is supplied to the alloy by oxygen transport processes, conversion of uranium into plutonium, and stoichiometry variations due to fission products. In the interior of the fuel pins a strong reduction of the mixed oxide occurs caused by the vanadium and titanium in the cladding material. (auth)

684 OXIDATION PROPERTIES OF A ZIRCONIUM–2.7 WT. PERCENT NIOBIUM ALLOY IN THE TEMPERATURE RANGE 650° TO 1000°C. Urbanic, V. F.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). J. Electrochem. Soc.; 119: No. 11, 1527-31(Nov 1972).

The reaction kinetics and structures of the alloy/oxide composite system were determined for a Zr-2.7 weight percent Nb alloy exposed at temperatures over the range 650 to 1000°C in oxygen at 1 atm pressure. These kinetics may be represented by a parabolic-linear relationship. The zirconia scales contained small amounts of the intramolecular oxide, $6ZrO_2 \cdot Nb_2O_5$. An investigation was carried out on the morphological development of the columnar scale and the underlying layer of oxygen stabilized α-Zr plates in the β-Zr alloy during parabolic oxidation. The sequence of the reaction product layers was consistent with predictions from the Zr–Nb–O phase diagram. (auth)

685 EFFECT OF OXYGEN ON THE COMPATIBILITY OF TANTALUM AND POTASSIUM. Klueh, R. L. (Oak Ridge National Lab., Tenn.). Corrosion; 28: No. 10, 360-7(Oct 1972).

Static capsule tests were used to study the effects of oxygen in each phase on the compatibility of tantalum and potassium at 600, 800, and 1000°C. As the oxygen concentration of the potassium was increased, the amounts of tantalum in potassium after test also increased. The results indicated the formation of an unidentified ternary oxide phase (probably at the tantalum–potassium interface) that is either nonadherent or dissolved when the potassium is dissolved for chemical analysis. On the other hand, when the tantalum specimens contained oxygen above a certain threshold concentration that depends on test conditions, potassium penetrated the tantalum, and both intergranular and transgranular attack occurred. The threshold levels for intergranular attack at 600, 800, and 1000°C were determined to be 500, 700, and 1000 ppM of oxygen, respectively. Again the explanation involves the formation of a ternary oxide phase. (auth)

686 EFFECT OF OXIDE THICKNESS ON THE HOT SALT STRESS CORROSION SUSCEPTIBILITY OF Ti–6Al–4V. Mahoney, M. W.; Paton, N. E. (North American Rockwell Science Center, Thousand Oaks, Calif.). Corrosion; 28: No. 10, 374-7(Oct 1972).

The hot salt stress corrosion susceptibility of Ti–6Al–4V was investigated at 454°C as a function of applied stress and pre-test oxidation temperature. Anodizing was also tested as a method of oxide application. For the prescribed test conditions, the threshold stress for the alloy was determined to be 20 to 25 ksi. Hot salt stress corrosion susceptibility, as determined by post-test ductility, was not significantly influenced by either pre-test oxidation temperature or the manner in which the oxide was applied. (auth)

687 PROPERTIES OF ZIRCONIUM BASE CLADDING MATERIALS: CORROSION AND HYDROGEN PICKUP. Videm, Ketil (Institutt for Atomenergi, Kjeller, Norway). Nucl. Eng. Des.; 21: No. 2, 200-11(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

Corrosion and hydrogen pickup by zircaloy in water and steam are described. Out-of-pile corrosion is treated briefly, as irradiation has major effects on the process. Main emphasis is on hydrogen pickup in-pile, as experience with the Shippingport Atomic Power Station core has led to the conclusion that susceptibility to hydriding is the major factor in determining the ultimate limits on the useful life of zirconium base cladding, rather than loss of wall thickness. The principal alloys used or considered are discussed. (auth)

688 DETERMINATION OF ENTHALPY OF OXIDATION OF Cr(II) AND V(II) IN SULFURIC ACID SOLUTION BY MEANS OF A CALORIMETER-ELECTROLYZER. Stenin, Yu. G.; Khanaev, E. I.; Ryabinina, E. P. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 4, Ser. Khim. Nauk; No. 2, 127-9(Mar 1972). (In Russian).

The enthalpies of oxidation of Cr(II) by hydrogen ions in solution (4% Cr and 2% H_2SO_4) and V(II) by hydrogen ions in solution (3% V and 2% H_2SO_4) were determined by means of electrochemical calorimetry. The values are: $\Delta H_1 = -17.72 \pm 0.11$ kcal/mol and $\Delta H_2 = -8.25 \pm 0.14$ kcal/mol. (auth)

689 NEW NIOBIUM BASED OXIDATION RESISTANT MATERIALS. Chevillon, Jack Rene Paul; Alois Gauje, Georges Maurice Celestin; Grammagnac, Jacques Leopold Emile (to Societe Nationale d'Etude et de Construction de Moteurs d'-Aviation). French Patent 2,102,632. 7 Apr 1972. Filed 12 Aug 1970. (In French).

The preparation of Nb or Nb alloy parts coated with protective coatings is described. These protective coatings consist of silicide or aluminide type Nb alloys. The surface layer of these coatings contains at least 70% by weight of metallic oxide of the (Nb, M_1, M_2, ...)$_2O_5\beta$ type, M_1 and M_2 being the metallic components of the protective layer which can be substituted for Nb to form a complex β form oxide. These parts are subjected to an oxidation reaction under operating conditions such that the rate of formation of β type Nb_2O_5 metallic oxides (pure or alloyed) is greater than the rate of formation of α type Nb_2O_5 metallic oxides (pure or alloyed). Temperatures between 700 and 1200°C are utilized during 50 hours. (France)

690 SPECULATION ON SOME EFFECTS OF COMPLEXATION AND ANION-INDUCED ADSORPTION ON THE POLAROGRAPHY OF INDIUM IN ACIDIC HALIDE AND THIOCYANATE MEDIA. Bond, A. M. (Univ. of Melbourne, Parkville, Australia). J. Electrochem. Soc.; 119: No. 11, 1503-10(Nov 1972).

Some phenomena found in the polarographic reduction of indium(III) in acidic halide and thiocyanate media have been studied by ac polarography. Speculation on the role of complex formation and anion-induced adsorption on the polarographic reduction at potentials near the half-wave potential are given. At low ligand concentrations the ac peak potential is believed to be influenced by anion-induced adsorption while at high ligand concentrations the value is the thermodynamic value predicted from bulk complexation equilibria. The unusual dc minimum found at more negative potentials and the above phenomena are discussed in terms of the coupled occurrence of electroinactive $[In(H_2O)x]^{3+}$ ions at potentials where the complexed ion is electroactive and anion-induced adsorption. The reduction mechanism at the halfwave potential and at more negative potentials is concluded to be similar. The irreversible reduction of the uncomplexed indium ion is attributed to the slow rate of exchange of co-ordinated water, in agreement with others. (auth)

691 STRUCTURE AND EROSION RESISTANCE OF SINTERED HEAVY-CURRENT Mo–Cu CONTACTS. Zhavoronkov, M. A.; Levchenko, G. V.; Minakova, R. V.; Teodorovich, O. K. (Moscow Electrical Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 313-17(Apr 1972).

Translated from Poroshk. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 72-8(Apr 1972).

Studies were made on the effects of composition and structure on the electroerosion resistance of arc-break contacts made of sintered composite materials. Mo–Cu composites alloyed with various amounts of Co were chosen for study. The results showed that alloying with Co profoundly altered the mechanism of rupture of contacts, which determines their erosion resistance. Adding Co to the composite increased the solubility of the Mo in the liquid phase, which altered the structure of the working zone of contacts made of this material. The crust thickness grew to 0.1 mm. It was concluded that the process of electroerosion wear of a sintered Mo–Cu–Co composite contact involves essentially the formation and destruction of a working layer. The results showed that alloying with Co improved the technological characteristics of Mo–Cu copper composite materials. However, raising the Co content above 3 wt % adversely affected the electroerosion resistance of contacts interrupting heavy currents. (P.C.H.)

692 OXIDATION OF TANTALUM. Kampe, Dennis James. Charlottesville, Va.; Univ. of Virginia (1972). 171p. University Microfilms Order No. 72-23,430.

Thesis.

Scanning electron microscopy (SEM) in conjunction with transmission electron microscopy (TEM) and optical microscopy was used to study the initial stages of the oxidation of high-purity {111} and {110} Ta single crystals and large-grained 5 mil thick sheet of approximately {001} orientation. Two different oxidation temperatures 530 and 800°C were used as well as two different pressures, 1 atmosphere and typically 10^{-9} torr oxygen. Only for the

case of the 530°C, low pressure did suboxide platelet formation occur which was analyzed using SEM, TEM, and selected area diffraction. High voltage electron microscopy (HVEM) indicated that a two fold superlattice was present in the {001} Ta surface while a tetragonal suboxide (a = 6.68 ± 0.03 Å, c = 4.76 ± 0.03 Å) with {112} TaO_2 had formed in the {111} Ta plane. Using SEM micrographs of surface oxide traces on two known planes, a {515} habit plane for the major oxide platelet formation was determined. Apparent effects attributed to carbon contaminant on the observed habit planes of the platelets oxidized in an oil diffusion pumped system were contrasted with the platelet growth under ultraclean conditions. Samples oxidized under the three other pressure-temperature conditions all showed tantalum pentoxide formation with 1 Atm. 800°C > 1 Atm. 530°C > low P. 800°C. In these three cases no substantial internal suboxide formation was observed, indicating little oxygen dissolution into the bulk had occurred. These results demonstrated the influence of oxidation pressure as well as temperature, time, orientation, etc., on the oxidation sequence and oxide formation. Modifications of the existing theories of the oxidation of Ta in the temperature and pressure ranges studied were made to include the pressure dependency. (Diss. Abstr. Int., B)

Preparation and Fabrication

Refer also to abstracts 214, 234, and 637.

693 (AECL–4251) ELECTRON PROBE MICROANALYSIS OF BONDS BETWEEN TITANIUM OR NICKEL AND TITANIUM ALLOYS. Gilbert, R. W. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1972. 20p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

As part of a seal development program, attempts have been made to bond a ductile metal (Ni or Ti) to a titanium alloy disc. Metallography showed segregates and intermetallics at the bond zones. Electron probe microanalysis identified various phases in specimens subjected to different bonding treatments. (auth)

694 (FRNC-CONF–47) LEVEL REGULATION IN URANIUM POURING SYSTEMS. Guichard, Cl.; Vignat, Ph. (Societe Industrielle de Combustible Nucleaire, Veurey (France). Societe Grenobloise d'Etudes et d'Applications Hydrauliques (France). 1972. 6p. (In French). (CONF-720648–18). Dep. NTIS (U. S. Sales Only).

From twelfth meeting on hydraulics; Paris, France (6 Jun 1972).

The continuous pouring system for the manufacture of uranium fuel rods is described. The following points were reviewed: principle and dimensions of the pouring system, control system design, flow characteristics and their simulation on a computer: adjustment of control parameters, problems related to liquid metal flow, application of the control system and the final design stage both on the pilot model at Veurey and on the industrial prototype. (France)

695 (IS–2968) PRODUCTION, QUALITY CONTROL, AND APPLICATIONS OF PURE RE METALS AND ALLOYS. Gschneidner, K. A. Jr. (Iowa State Univ. of Science and Technology, Ames). 1972. 10p. (CONF-720839–4). Dep. NTIS.

From Analysis and application of rare earth materials conference; Kjeller, Norway (23 Aug 1972).

The light lanthanide metals are usually prepared by the metallothermic reduction method using Ca or Li, or by the electrolytic method. Yttrium and the heavy lanthanides are prepared only by the Ca or Li reduction method. The volatile lanthanides, Sm, Eu, Tm, and Yb are prepared by the La reduction of the oxide. Mischmetal, primarily because of economic reasons, is prepared electrolytically. The quality control with respect to the production of high purity rare earth metals is discussed. The important metallurgical uses of the rare earths are examined, and the reasons for the utilization are noted. (20 references) (auth)

696 (LA–3295) CHEMICAL VAPOR DEPOSITION OF TUNGSTEN. Fairchild, C. I.; Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). 1 Mar 1965. Contract W-7405-eng-36. 34p. Dep. NTIS.

Declassified 26 Oct 1972.

Investigation of the effect of coating parameters for the vapor deposition of tungsten from WF_6 by hydrogen reduction is described. Deposition conditions ranged from 300 to 1000°C, pressures from 10 torr to 1 atm, and H_2/WF_6 ratios from 6/1 to 60/1. The tungsten was deposited as a protective coating on tungsten, molybdenum, or Mo–40 v/% UO_2 cylindrical samples. These coated cylinders were subjected to high-temperature tests. Metallographic, x-ray diffraction, and chemical and electron microprobe analyses were obtained on as-coated and post-heated samples in order to characterize the coating and determine its effectiveness for the prevention of UO_2 losses at elevated temperatures. (auth)

697 (RFP–1842) IMPROVED TECHNIQUE FOR PRODUCING HIGH SURFACE FINISH BERYLLIUM FOIL. Avery, John G.; Norris, James F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 2 Oct 1972. Contract AT(29-1)-1106. 9p. Dep. NTIS.

A method of producing beryllium foil with a better surface finish than present foil, and at a lower cost than the present method, has been conceptually developed. This method is performed with the rolls and the beryllium at 800°F, which is just below the temperature at which significant oxidation of beryllium begins. Subsequent annealing at 1200°F in a 10^{-6} torr vacuum produces a ductile foil whose surface does not require etching to remove oxide. (auth)

698 (SC-DR–720731) EFFECT OF FABRICATION CONDITIONS ON THE MECHANICAL PROPERTIES OF BERYLLIUM–ALUMINUM COMPOSITES. Ericksen, R. H. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 18p. Dep. NTIS.

The effect of fabrication conditions on the mechanical properties of Be-Al monolayer tape and composite specimens fabricated from several different lots of beryllium wire was investigated. Properties of the beryllium filaments, particularly the ductility, varied with heat treatment and the changes in ductility were not the same for each filament lot. Testing of monolayer tape specimens was shown to be useful in minimizing the number of test conditions required to determine composite fabrication parameters. It was also shown that ductile Be composites could be fabricated by short time hot pressing followed by an auxiliary high temperature heat treatment. The Be-Al composite stress-strain curves exhibited a yield point, an observation not previously reported. A Lüders band front passed through the composite during the yield point elongation and the front velocity was measured to be 0.01 ± 0.003 in./sec. The yield point phenomenon was also observed in the filaments and a synergistic interaction with the matrix produced the composite yield point behavior. (auth)

699 WELDING OF NIOBIUM VN1 AND VN2 ALLOYS WITH VT1 AND OT4 ALLOYS. Shchetanov, D. P. Svar. Proizv.; No. 7, 18-19(1971). (In Russian).

The best protection for the liquid metal in the welding bath between dissimilar, chemically active metals and alloys is a high vacuum. Therefore, welding of VN1 and VT1 was performed by the cathode-ray method in a vacuum of $5 \cdot 10^{-5}$ mm Hg. High-quality welded joints can be produced in all of the metals mentioned as long as the beam energy between the ends of the welded parts is precisely controlled to take into account the difference in melting points of the metals involved. (JPRS)

700 FILLER MATERIALS FOR ELECTROSLAG SURFACING OF STEEL ROLLS. Daemen, R. A.; Blaskovic, P. Zvaranie; 20: No. 8, 234-9(Aug 1971). (In Slovak).

Nine experimental materials were used for electroslag surfacing studies, i.e. low-C low-alloy, low-C medium-alloy, medium-alloy containing Ti carbides, medium alloy containing Nb carbides, medium alloy containing V carbides, low-alloy hypereutectoid, medium alloy hypereutectoid, low-alloy cast iron, and high Cr alloys. Microstructures are shown. Tests of the thermal-shock resistance are described. (Metals Abstr.)

701 [PREPARATION OF] SINGLE CRYSTALS OF REFRACTORY RARE METALS. Pikunov, M. V. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 182-9(1971). (In Russian).

Methods for the production of single crystals of refractory rare metals are described and a short review is given of the use of these crystals in scientific and technical applications. Electron floating-zone melting techniques in the USSR and other countries are described. General consideration is given to the questions of impurity distribution during the zone melting, the preferred direction of growth, the preparation of single crystals which suffer polymorphic transformations, and structural perfection. (Referativnyi Zh.)

702 ZIRCONIUM ALLOYS DISPERSION STRENGTHENED WITH YTTRIA. Parsons, P. D.; Adolph, E. (United Kingdom Atomic Energy Authority, Springfields). Can. Met. Quart.; 11: No. 1, 223-35(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

A powder metallurgy process for the manufacture of zirconium alloys dispersion strengthened with yttria particles is described. The resulting alloys contain a suitable dispersion of stable yttria particles in a fine-grained matrix. Tensile and stress rupture tests over a range of temperature on Zircaloy-2 containing 0, 5,

and 10 vol% yttria showed the strength of yttria-containing alloys to be significantly improved. The post-irradiation tensile properties of Zircaloy-2-yttria alloys have been determined with alloys irradiated at 280°C to 9.2×10^{20} n/cm² thermal and 2.3×10^{20} n/cm² fast. The alloys have been subjected to accelerated corrosion tests in steam and exhibit a variable response. Some possible detrimental factors and means of improvement of properties are discussed. The mechanical properties of Zircaloy-2 alloys containing yttria particles were compared to some other zirconium alloys, Zircaloy-2, and zirconium-2.5 wt% Nb, and the results showed that the dispersion-strengthened alloys are worthy of further development. (auth) (Canada)

703 HARDFACING OF COBALT-CHROMIUM-X-ALLOYS BY ARC WELDING. Van Muysen, L. (Arcos, S.A., Brussels). Kobalt; No. 55, 53-62(1972). (In German).

New findings in the field of hardfacing with cobalt-base alloys are discussed, as well as electrodes with ductile cobalt core rods, shielding material consisting of all alloying elements, except for Co, and filler wires consisting of a tube made from a ductile cobalt strip. This tube contains all other elements required besides the fluidizer in the form of powders, and is cold-drawn to any desired size. The advantages of the high-capacity electrodes over the shielded electrodes with cast core rods are as follows: possibility of producing rod electrodes with smaller diameters, improved ductility, higher rates of welding, and reduced mixing with the base metal. Filler wires permit hardfacing with cobalt-base alloys according to a mechanized procedure, (UP, MIG, and plasma). The use of both filler materials, also in nuclear installations, the structure of the hardfaced welds and the mixing ratio are outlined. Both conventional Co-Cr-W-C-types (Types 1, 6, and 12), the Mo- and Ni-modified types (Type 7: Co-30Cr-5 Mo-0.3C, and type 25: Co-20-Cr-10Ni-15W-0.1C), as well as the Co-Fe-Cr-type (Type 50) are discussed. (GF)

704 PRODUCTION TECHNIQUE FOR POWDERS OF NICKEL-BASE SOLDER ALLOYS. Borok, B. A.; Shchegoleva, R. P.; Golubeva, L. S.; (and others) (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 82-8(May 1972). (In Russian).

A production technique was developed for powders of alloy solders of the system Ni-Cr-Si-Fe-B as well as for powders of solder No. 6MA, which is a mechanical mixture of 85% of the above alloy powder and 15% molybdenum. Soldering of high-alloyed steels with powdery solder No. 6MA ensures an increase in temperature of the secondary melting (unsoldering) of the soldered weld. (auth)

705 DEGASSING OF METALS BY REDUCTION MELTING. THE CASE OF OXYGEN IN NIOBIUM. Eymery, J. P.; Chevallier, J.; Desre, P.; Spitz, J. P. (CEN, Grenoble, France). Mem. Sci. Rev. Met.; 69: No. 5, 365-73(May 1972). (In French).

The phenomena (such as temperature, pressure, viscosity of the alloy) which limit the oxygen extraction in the reduction melting of Nb in the presence of a metallic bath were studied. The bath-Nb-C alloy was then obtained, the bath being composed of a Fe-Ni 20-80 alloy. The formation and growth of CO bubbles inside the molten alloy and the removal of the CO produced were investigated. (France)

706 ELECTROLYTIC DEOXIDATION OF LIQUID METALS AT 1600°C. Fischer, W. A.; Janke, D. (Max-Planck-Institut fuer Eisenforschung. Duesseldorf). Scr. Met.; 6: No. 10, 923-8(Oct 1972).

Results of studies of electrolytic deoxidation of liquid Fe, Co, Ni, and Cu are presented. Results show that oxygen removal by electrolysis frees the liquid metal of oxide inclusions which are invariably present when melts are deoxidized using solid deoxidants. (J.R.D.)

707 PRODUCTION AND TESTING OF EXPLOSION-CLAD COMPOUND MATERIALS. Richter, U. Schweissen Schneiden; 24: No. 2, 52-5(Feb 1972). (In German).

The mechanism of the explosion cladding operation is discussed and the advantages of the process compared with hard facing and roll cladding are described. Materials that can be explosive clad include steel with Al, Mo, Ta, Ti, Zr, and Cu with Al. The corrosion resistance of cladding materials are not affected by explosive cladding. The methods of testing the metallic bond between the materials by tensile, torsion, and shear tests and by ultrasonic testing, are mentioned and methods for studying whether changes in the mechanical properties have taken place in the materials are also discussed. 12 references. (Metals Abstr.)

708 METALLOGRAPHIC ANALYSIS OF URANIUM. Ambrozio Filho, F.; Gentile, F. E. (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo); 27: No. 163, 415-20 (Jun 1971). (In Portuguese).

Metallographic control of uranium fabrication, as developed at the Instituto de Energia Atômica's Division of Nuclear Metallurgy is described. Methods for the preparation of uranium samples were studied. Mechanical, both manual and vibratory polishing methods, were compared with electrolytic polishing. The adopted techniques for the identification of carbides, oxides, nitrides, and slag inclusions are also presented. A comparison among uranium samples obtained through different processes is given. (INIS)

709 ARGON ION SPUTTERING OF METALLIC SURFACES FOR ESCA STUDIES. Huefner, S.; Cohen, R. L.; Wertheim, G. K. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Scr.; 5: No. 1-2, 91-2(1972).

The use of the argon ion sputtering technique for the cleaning of metallic surfaces in ESCA studies is demonstrated. (auth) (Sweden)

710 PRODUCTION OF POWDER METALLURGICAL COMPONENTS OF COMPLEX CONFIGURATION. Matusevich, I. S. Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 294-6 (Apr 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 49-52(Apr 1972).

A method for the production of powder metallurgical components consists of mixing a metal powder constituting the matrix of the alloy being produced with a binder, which yields a slip with the consistency of a paste or soft dough. The operation is performed at low temperatures (between 0 and -15°C) to prevent the slip from solidifying prematurely. The resultant slip is forced, under a pressure ranging from 200 to 1000 kg/cm², into a steel mold preheated to 50 to 200°C and coated, to prevent sticking, with a solution of heat-resisting rubber. As the slip is heated up to room temperature by the hot mold, it begins to solidify spontaneously as a result of polymerization of the binding oxysalt solution under the action of the metal powder. After slip solidification, the mold is stripped. The resultant part, having a strength of 5 to 15 kg/cm², is subjected to drying and firing. During firing, the metal powder sinters together, while the aluminum oxynitrate or oxychloride decomposes with the formation of polymeric alumina, which strengthens the powder metallurgical alloy. When it is desired to produce powder metallurgical alloys strengthened with oxides other than Al_2O_3, such as BeO, ZrO_2, and ThO_2, water-alcohol solutions of the following Be, Zr, and Th basic salts (oxysalts) may be used as binders: $Be_n(OH)_{2n-1}NO_3$, $Be_n(OH)_{2n-1}Cl$, $Zr(OH)_{4n-1}NO_3$, $Zr(OH)_{4n-1}Cl$, $Th(OH)_{4n-1}NO_3$, and $Th(OH)_{4n-1}Cl$. (P.C.H.)

711 MANUFACTURE OF FUEL ELEMENTS WITH A HIGH BURN UP. Bairiot, H. (to Societe Belgonucleaire, SA). Belgium Patent 714,951. 10 May 1968. (In French).

A process described is for the fabrication of fuel rods with enriched fissionable material. The procedure is based on the vibrocompaction technique and uses a mixture of grains with diverse diameters. The procedure is characterized by the fact that the grains with the largest diameter contain more fissionable material than the mean content of the fuel. The large grains are chosen with respect to the internal dimensions of the cladding of the fuel element. The cladding of the fuel rod has a tubular shape. The large grains have dimensions varying from ½ to ⅓ of the internal diameter of the cladding. The fuel rod is described and depicted. (H.B.G.)

712 RESEARCH ON ZIRCALOY FUEL CLADDING TUBES FOR NUCLEAR POWER REACTORS. Kondo, Yutaka; Kodama, Tatsuro; Konishi, Takao (Sumitomo Metal Industries, Ltd., Amagasaki, Japan). Sumitomo Kinzoku; 23: No. 4, 552-63 (Oct 1971). (In Japanese).

Main aspects in research and development of Zircaloy fuel cladding tubes for nuclear power reactor services are reviewed. Starting with basic studies on the metallurgical characteristics of the material, all stages of manufacturing processes of cladding tubes such as preparation of the feed material and alloying elements to be consumable electrodes are melted in vacuum. Other items described are adjusting oxygen content of the alloy, homogenizing heat treatment to improve corrosion resistance, copper-coated extrusion techniques, development of tube reducing techniques, research on the relationship between mechanical properties and cold working conditions, and also on the hydride precipitation characteristics. Results of this research and development have been integrated into a Zircaloy tube plant where all processes from material preparation through finished tube inspection are executed with sufficient capacity to meet immediate demand. Considerable amount of products have been delivered to customers and have acquired favorable evaluation. All cladding tubes sub-

jected to in-reactor irradiations have performed satisfactorily, none indicating fracture or any other defect. (auth) (Japan)

713 IRON MANUFACTURING BY ATOMIC ENERGY. Adachi, Akira (Osaka Univ., Suita, Japan). Cho-Koon Kenkyu; 8: No. 3-4, 1-17(Nov 1971). (In Japanese).

Atomic energy is expected to supply enough energy for iron manufacturing process which needs enormous energy. When the atomic energy is employed for the iron manufacturing process, two methods are considered. One is the method to use generated electric power for the iron manufacturing, and another is to combine atomic thermal energy and the generated electric power with the iron manufacturing process. Direct utilization of the thermal energy is three times profitable than utilization of the converted electric power. The most promising method seems to be use of high-temperature gas-cooled reactors. A sectional meeting on atomic energy was established in the Japan Iron and Steel Association in 1968 and many subcommittees in that section have been studying the problems associated with iron manufacturing using atomic energy, selection of optimum reactors for producing heat energy required for reducing gas and for the combination with shaft furnaces and fluidized bed furnaces in connection with outlet gas temperature, and problems of permeation of hydrogen gas to helium gas side through heat exchangers. Commercial profit when the atomic energy is adopted to the iron manufacturing process is experimentally estimated. Finally, the present situation on the studies of iron manufacturing by atomic energy in foreign countries is introduced. (Japan)

714 NUCLEAR REACTOR STEEL AND QUALITY CONTROL. Oda, Toyohisa (Japan Steel Works, Ltd., Muroran). Karyoku Hatsuden; 23: No. 1, 92-101(Jan 1972). (In Japanese).

Manufacture and quality control of steel for reactor pressure vessels are discussed. The steel vessels of large size and large thickness are used for recent power reactors, and high integrity is required for these materials. ASME Sec. III is considered as the standard of their quality. In the manufacture of the steel for RPVs, both internal quality such as chemical composition and defects and mechanical properties such as tensile strength and ductility must be guaranteed. Attention must be paid to production of steel ingots and pretreatment before last heat treatment especially, and quality of products must be checked during processes. Efforts to produce materials of high quality have been made from a metallurgical view point. Segregation in the steel ingots can be reduced by improvement in manufacturing processes, and the tensile strength or the ductility are increased by the change in the condition of heat treatment or impurity content. Ideas on organization and system for the quality control are stated. (Japan)

Properties, Structure, and Phase Studies

Refer also to abstracts 226, 425, 626, 635, 656, 658, 664, 671, 1474, 1868, 1878, 1879, 1886, 2212, 2214, and 2222.

715 (AE-MF-248) TENSION FATIGUE AND CREEP IN ZIRCALOY-2. Pettersson, K. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 17 Dec 1971. 19p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Test rods taken from Zircaloy-2 fuel cans in latitudinal direction were tension fatigued at 25, 250, 300, 350, and 400°C. The material followed Coffin–Manson's equation $N_f^{\alpha} \cdot D\epsilon_p = C$ with $x \approx 0.5$. Already at relatively small axial tensions during bending fatigue, a strong ratchetting was obtained. At ratchetting deformation the material showed a considerably greater area reduction before crack than at an axial tension. A test with creep in combination with tension fatigue showed that there is a strong interaction between these phenomena in Zircaloy-2. (Sweden)

716 (AE-MF-249) HIGH CYCLE FATIGUE CRACK GROWTH OF TWO ZIRCONIUM ALLOYS. Rao, Subba (Aktiebolaget Atomenergi, Studsvik (Sweden)). 14 Dec 1971. 25p. Dep. NTIS (U. S. Sales Only).

High cycle fatigue crack growth studies in an environment of room temperature air, at zero to tension stress range levels, $\Delta\sigma$, not exceeding 30% yield strength, of Zircaloy-2 and Zr–2.5% Nb sheet materials were carried out. The effect of hydrides, about 300 ppM H, was also investigated. It was found that the crack growth rate of all the materials could be represented by a power rate law of the type $da/dN = C(\Delta K)^n$ where da/dN is the rate of growth (per cycle) ΔK the stress intensity range, C and n are constants. The value of $n \simeq 3$ for all the materials. The total effect of H was to increase the crack growth rate by increasing C but not n. This is to be compared with S–N data, according to which hydriding increased the life. The rate was higher for hydrided Zr–Nb alloy than for the corresponding Zircaloy-2 at a particular stress level. The conclusion was that Zr–Nb was not better than Zircaloy-2, despite its higher strength. Threshold ΔK or $\Delta\sigma$ values where no crack propagation occurred at any measurable rate were obtained. There were no appreciable differences between the materials. Furthermore, the investigation showed that Zr–Nb alloy, at least in the present solution treated and aged condition and especially in the hydrided state, has less fracture toughness than Zircaloy-2 since the extent of crack propagation before final failure is much less. (auth) (Sweden)

717 (AECL–3953) PRELIMINARY SURVEY OF LOW FREQUENCY INTERNAL FRICTION IN SOME ZIRCONIUM ALLOYS USING AN IMPROVED TORSION PENDULUM. Putnam, J.; Ritchie, I. G.; Hughes, F. J. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sep 1972. 40p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

A basic approach to a study of the low frequency internal friction of zirconium and its alloys is outlined. To investigate point defect relaxation peaks associated with alloy additions the number of grain boundaries was reduced by using wire specimens with a bamboo structure. To test these specimens, an improved torsion pendulum was developed with associated electronic data handling facilities. Damping peaks in zirconium have been measured from room temperature to 700°C at a frequency of 1 to 3 Hz. Damping has been measured using the pendulum in both its decay and its constant strain amplitude modes, and shown to be quantitatively similar. The experimental errors of both these modes have been analyzed and found to be similar. Damping peaks due to the α/β phase transformation, grain boundary sliding and stress-induced reorientation of substitutional-interstitial atom pairs have been observed. These results are discussed and their importance to possible strengthening mechanisms in zirconium alloys is indicated. The improved torsion pendulum has proved to be ideal for studying point defect relaxation peaks in zirconium alloys, and recommendations are made for detailed investigation of this phenomenon. (auth)

718 (AERE-R–6891) SIGNIFICANCE OF APPLIED STRESS IN THE SWELLING OF IRRADIATED MATERIALS. Anderson, R. G.; Bullough, R.; Foreman, A. J. E.; Harrison, J. W.; Perrin, R. C. (Atomic Energy Research Establishment, Harwell (England)). Aug 1971. 31p. Dep. NTIS (U. S. Sales Only).

The effects of applied stress on the growth of voids in irradiated materials were studied. The various possible mechanisms that permit an interaction between such stresses and the voids are described, and where possible, their relative significance is assessed. It is suggested that hydrostatic tension should cause an important increase in the swelling in the high temperature region between the maximum stress free swelling temperature and the cut off temperature. The predictions are illustrated by using physical parameters appropriate to nickel. (auth)

719 (COO–2107-6) CORRELATION OF SUBSTRUCTURE WITH MECHANICAL PROPERTIES OF PLASTICALLY DEFORMED AISI 304 AND 316 STAINLESS STEEL. Progress Report, January 1, 1972–March 31, 1972. Moteff, J. (Cincinnati Univ., Ohio. Dept. of Materials Science and Metallurgical Engineering). 15 May 1972. Contract AT(11-1)-2107. 40p. Dep. NTIS.

A program to evaluate the substructure of austenitic stainless steels (Types 304 and 316) deformed at elevated temperatures in the creep, tensile, and fatigue modes is being conducted. Initial substructure results are discussed for 316 stainless steel creep-rupture specimens from a second heat of material. The results were consistent with the previously reported substructure results for 316 material in this program. Below $\sim 0.5\ T_m$, dislocation cells were the predominant feature while subgrains were evident at higher deformation temperatures. Substructure results are reported for 304 stainless steel tested in the creep mode where testing was terminated at pre-selected levels of deformation and for tests involving an abrupt decrease in load at a pre-selected stain level. Results are reported from a study of intergranular crack formation in 304 stainless steel tested at 650°C in the creep-rupture and tensile modes. Optical microscopy indicated that the maximum number of cracks occurs at angles near ~80° to the direction of the applied stress for the creep specimens. A majority of the cracks in the creep specimens were one grain boundary facet in length, in agreement with the previously reported results for tensile specimens from the same heat of material. Bulk density changes due to the crack formation are discussed for both the tensile and creep specimens. Preliminary results are reported from a study of the substructure of 316 stainless steel thin-wall tubing biaxially crept at 650°C by internal pressurization. (auth)

720 (FRNC-CONF-38) LIQUID METALS. Chaminade, F. (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson (France)). 1972. 18p. (In French). (CONF-720648-13). Dep. NTIS (U. S. Sales Only).

From twelfth meeting on hydraulics; Paris, France (6 Jun 1972).

A brief discussion of the properties of liquid Na is presented. Applications as a coolant fluid, particularly in the field of fast nuclear reactors, are discussed. Hydrotechnical problems associated with its use are considered. The properties of other liquid metals and their applications to magnetohydrodynamics are reviewed. (France)

721 (IS-2965) GENERAL REVIEW OF SCIENTIFIC AND TECHNOLOGICAL ASPECTS OF THE UTILIZATION OF RE MATERIALS. Gschneidner, K. A. Jr. (Iowa State Univ. of Science and Technology, Ames). 1972. 9p. (CONF-720839-1). Dep. NTIS.

From Analysis and application of rare earth materials conference; Kjeller, Norway (23 Aug 1972).

The major uses and some of the more promising potential applications were examined from a scientific and technological view. This led to the subdivision of these applications into four groups: those uses based on (1) the similar chemical nature of the rare earths, (2) the 4f electrons, (3) valence states different than +3, and (4) nuclear properties. In general, the mixed rare earths are used primarily in (1) and the separated individual elements in (2), (3), and (4), although some notable exceptions are found. The scientific basis for the various applications is briefly discussed. (auth)

722 (IS-2966) FUNDAMENTAL PROPERTIES OF RE ELEMENTS AND THEIR IMPLICATIONS ON THE ANALYTICAL CHEMISTRY OF RE MATERIALS. Gschneidner, K. A, Jr. (Iowa State Univ. of Science and Technology, Ames). 1972. 24p. (CONF-720839-2). Dep. NTIS.

From Analysis and application of rare earth materials conference; Kjeller, Norway (23 Aug 1972).

The electronic configurations of the metallic state, the ground state (gaseous atoms), and the trivalent ions of the rare earth elements are given. The relationship between these configurations and the chemical and physical properties of the metals and some of the important compounds are discussed. A separate section is devoted to the spectra of the rare earth elements. Some comments are made regarding the influence some of these properties have on various analytical techniques. (19 references) (auth)

723 (IS-2967) MISCELLANEOUS USES OF RE MATERIALS (CERAMICS, GLASSES, NUCLEAR APPLICATIONS, ETC.). Gschneidner, K. A. Jr. (Iowa State Univ. of Science and Technology, Ames). 1972. 13p. (CONF-720839-3). Dep. NTIS.

From Analysis and application of rare earth materials conference; Kjeller, Norway (23 Aug 1972).

The more important commercial uses of the rare earth elements in ceramics, glasses, and the nuclear area are described. Several other (miscellaneous) applications, which are not included in the various categories reviewed at the Conference, have been noted and discussed. A few unusual uses are also mentioned in the four categories reviewed. (37 references) (auth)

724 (ORNL-4828) COMPUTER PROGRAM FOR THE REDUCTION OF DIFFUSE X-RAY DATA FROM SOLID SOLUTIONS. Williams, R. O. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 33p. Dep. NTIS.

This report documents a computer program to reduce the diffuse x-ray scattering data from cubic alloys by a multiple regression analysis. The solution provides information on the short-range order and the atomic displacements. The advantages of the present method are that it provides increased freedom in making observations, fewer approximations are required, and a complete error analysis is obtained. (auth)

725 (ORNL-TM-3969) FUELS AND MATERIALS DEVELOPMENT PROGRAM QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JUNE 30, 1972. Patriarca, P. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 114p. Dep. NTIS.

Research and development progress is reported on advanced fast breeder reactor fuels, compatibility of steam generator materials, FBR neutron absorber materials, FBR oxide fuels, joining structural materials, radiation effects on reactor materials, properties of structural alloys, nondestructive testing, heat source cladding materials, UN fuels, and metallurgy of refractory alloys and metals. (J.R.D.)

726 (RFP-1856) PROPERTIES OF BERYLLIUM MATRIX. Dykes, D. H. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 20 Sep 1972. Contract AT(29-1)-1106. 20p. Dep. NTIS.

Beryllium matrix is a light-weight structural material composed of sintered beryllium powder which contains a uniform distribution of spherical voids. Samples of the material tested in compression have an ultimate strength of about 400 pounds per square inch at a density of about 0.16 grams per cubic centimeter. Because of the difficulty in testing this open framework type of material, a hollow hexagonal billet was made employing the same processing parameters as used for the beryllium matrix which could be tested by conventional methods. Tensile specimens from the hexagonal billet showed no plastic strain at fracture, but ultimate tensile strengths were about 70 thousand pounds per square inch. Compression specimens exhibited almost 40% plastic strain at about 238 thousand pounds per square inch ultimate strength. (auth)

727 (SC-RR-720635) REACTION OF WATER VAPOR WITH U-7½ WT. PERCENT Nb-2½ WT. PERCENT Zr AND U-4½ WT. PERCENT Nb. Magnani, N. J.; Romero, H. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 15p. Dep. NTIS.

Coupons of U-7½ wt % Nb-2½ wt % Zr and U-4½ wt % Nb were exposed to water saturated nitrogen and oxygen to determine the rate of water vapor with the alloys. The data showed that the alloys reacted more slowly than uranium and that oxygen inhibited the reaction. Stress corrosion tests were also conducted to determine the effects of the environments on the cracking behavior. In moist environments the data showed that the ternary alloy does not stress corrosion crack in nitrogen but cracks readily in air while the binary alloy cracks with equal ease in both environments. (auth)

728 (WARD-3791-47) VANADIUM ALLOY CLADDING DEVELOPMENT. Final Report. Whitlow, G. A.; Nadler, R. A.; Svedberg, R. C. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Nov 1970. Contract AT(30-1)-3791. 201p. Dep. NTIS.

Three vanadium alloys were developed by Westinghouse [VANSTAR-7 (V-9 Cr-3 Fe-1.3 Zr-0.05 C), VANSTAR-8 (V-8 Cr-10 Ta-1.3 Zr-0.05 C), VANSTAR-9 (V-6 Fe-5 Nb-1.3 Zr-0.05 C)] that were identified as possessing characteristics that justified evaluation of these alloys for use as fuel cladding materials in fast breeder reactors. The scale-up of alloy compositions to pilot size ingots, and processing to a variety of mill shapes are described along with subsequent physical and mechanical properties evaluation. Two alloy compositions (V-20 Ti and V-15 Cr-5 Ti), developed at the Argonne National Laboratory, were used as a basis for the evaluation. Fabrication of sheet, bar, and tubing indicated that the alloys were suitable for cladding materials provided that sufficient ingot working is performed prior to initiation of tube manufacturing. In the 600°C tensile tests, strain aging was observed for V-20 Ti and the VANSTAR alloys. VANSTAR-7 and -8 possess short-time tensile properties significantly inferior to those of V-20 Ti and VANSTAR-9. Low ductile-brittle bend transition temperatures were obtained for coarse and fine-grained VANSTAR-7, and -8, and V-20 Ti; VANSTAR-9 was found to be more sensitive to grain size. Creep tests of the VANSTAR alloys revealed exceptional creep resistance at 700 and 800°C at stresses below and above the short-time yield stress; additional experiments revealed a high dependence of creep behavior on test environment, indicating a need for identification of reactor operating atmospheres before determining the design creep properties of fuel cladding. Vanadium and several vanadium alloys were also evaluated as potential fuel cladding materials in an LMFBR system. Since vanadium is a highly reactive metal and has a large capacity for absorbing interstitial elements from the liquid sodium coolant, a study was conducted to determine the relative reactivities of unalloyed vanadium and three vanadium alloys with oxygen and nitrogen via gas-metal reactions in a high vacuum at low partial pressures, and with carbon at low activities in a flowing gas system. The rate of weight gain as a function of temperature and pressure was the criterion by which the reactivity of the alloys was evaluated in a given environment. The effects of the various interstitial contamination levels on the ductile-brittle behavior and on the room and elevated temperature tensile properties were also examined. Over the oxygen partial pressure range (10^{-5} to 10^{-7} torr) and over the temperature range (600 to 800°C), it was found that linear kinetics best described the rate of oxygen pickup; the linear rate constant was directly proportional to the oxygen partial pressure and was not affected by the alloying addition to the vanadium. The results of the nitrogen exposure indicate that the reaction rate of unalloyed vanadium is about 5 to 10 times faster than is the reaction rate of the vanadium alloys with nitrogen. In addition, the reaction rate of the alloys and unalloyed vanadium in nitrogen is about one order of magnitude slower than the reaction rate of the same materials in oxygen at a given temperature and

pressure. It was also found that nitrogen is a more effective strengthener per amount dissolved than is oxygen. Attempts to contaminate the vanadium alloys with carbon via CO/CO_2 gas mixture resulted in the formation of V_2O_3 on the surface of the sample along with the carbon pickup. It was found that the V–Cr alloy showed the largest tolerance for interstitial contamination; at 600°C it exhibited an ultimate tensile strength of 77,000 psi with 2000 ppM oxygen pickup and retained about 25% measure elongation. An experimental program is described in which the objective was to examine the compatibility of the series of VANSTAR alloys with flowing, low oxygen sodium and with several sodium bonded carbide fuels. The corrosion of the VANSTAR alloys by liquid sodium in the temperature range 600 to 800°C results from the transfer of carbon and nitrogen from the stainless steel containment tubing to the vanadium alloys and from oxygen present in the sodium. Absorption of these interstitials by the alloys and their loss from the stainless steel was monitored by weight gain determinations, metallography, microhardness, and chemical analysis. The post corrosion room temperature tensile properties of these vanadium alloys were significantly degraded, but no intolerable deterioration was recorded in samples tensile tested in the range 150 to 800°C. The effects of exposure to sodium under these conditions are dependent on the stainless steel to vanadium exposed surface area and the temperature at the stainless–sodium surface. In 3500 hour compatibility tests at 800°C, some incompatibility was observed between three vanadium alloys and sodium bonded carbide fuels. The formation of an oxycarbide phase on the fuel pellet surface by reaction of the oxygen in the sodium bond with the fuel is tentatively thought to be the mechanism for the postulated carbon absorption and observed metallographic and microhardness changes in the vanadium alloys. There are indications that less incompatibility occurs with $Cr_{23}C_6$ modified (U, Pu)C than with hyperstoichiometric (U, Pu)C or stoichiometric UC fuels. Comparisons are made with compatibility data for oxide fuel. It was not possible to advocate the preferential selection of any one of the three VANSTAR alloys from these sodium and fuel compatibility studies. (auth)

729 (Y-DA-4818) ANALYTICAL APPLICATIONS OF ELECTRON OPTICAL INSTRUMENTATION. Ferguson, J. E. (Oak Ridge Y-12 Plant, Tenn. (USA)). 28 Aug 1972. Contract W-7405-eng-26. 11p. (CONF-721025-4). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

The use of transmission electron microscopy (TEM), scanning electron microscopy (SEM), and electron probe microanalysis for various types of material characterizations, particularly microchemical analysis of small specimens and small areas of specimens, is discussed. Examples of recent studies that demonstrate the microanalytical application of these disciplines are given. Thin parts of a U–Ti alloy that show increase in strength due to precipitation of U_2Ti on aging at moderate temperatures were examined by TEM. Crystallographic data were correlated with microstructure observed in electron micrographs for a better understanding of the hardening mechanism of this alloy. Reactor beads of carbonized uranium-loaded ion exchange resins were ion thinned and examined by TEM. Identification, size, and distribution of the loading species were determined. Results of SEM fractographic study of uranium–7.5 wt % niobium–2.5 wt % zirconium alloy are given. (J.G.B.)

730 SOLUBILITY OF NEODYMIUM AND ZINC IN SOLID MAGNESIUM. Drits, M. E.; Padezhnova, E. M.; Miklina, N. V. Tekhnol. Legkikh. Splavov. Nauch.-Tekh. Byul. VILSa; No. 1, 32-5(1971). (In Russian).

Microstructural analytical methods were used to study alloys in the Mg–Nd–Zn system containing Nd ≤ 3% and Zn ≤ 8%. The phases Mg_9Nd, MgZn, and X, Y, and Z were found in equilibrium with the Mg-based solid solution; the crystal structures of X, Y, and Z were not established. Isothermal sections were constructed for the part of the system studied at 200, 250, and 300°C. Nd and Zn mutually reduced their solubilities in solid Mg. (Referativnyi Zh.)

731 EFFECT OF HEAT TREATMENT ON THE STRUCTURE AND MECHANICAL PROPERTIES OF NIOBIUM ALLOYS ALLOYED WITH CARBON. Tikhonova, G. S.; Mel'nikova, L. V.; Zheleznyak, O. N.; Konovalov, S. V. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 50-6(1971). (In Russian).

Studies were made of the structure and mechanical properties of the Nb alloy 5VMTs containing C 0.05% which has a heterogeneous structure. The mechanical properties of sheet material at elevated temperature depended on the phase composition, which in turn was governed by the heat treatment. (Referativnyi Zh.)

732 STUDY OF INTERDIFFUSION IN THE VANADIUM–GALLIUM SYSTEM. Vorob'eva, N. S. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 123-9(1971). (In Russian).

Determinations were made of the coefficient of interdiffusion in the V_3Ga phase of the V–Ga system over the temperature range 900 to 1050°C. The temperature dependence of this coefficient was obtained. (Referativnyi Zh.)

733 EFFECT OF BOUNDARY PRECIPITATES OF CARBIDES ON THE PROPERTIES OF CREEP-RESISTANT ALLOYS. Paisov, A. I.; Anisimova, G. V.; Ryskina, E. V.; Usacheva, G. P. Tekhnol. Legkikh Splavov, Nauch.-Tekh. Byull. VILSa; No. 1, 46-9(1970). (In Russian).

The mechanical properties of three creep-resistant alloys for turbine discs were determined in relation to carbide precipitation. The Ni alloys were (i) EI 698 [C 0.08, Cr 13 to 16, Ti 2.35 to 2.75, Al 1.3 to 1.7, Mo 2.8 to 3.2, B 0.0005, Ce 0.005, and Fe < 2.0%], EI 698 with Co additions, and an alloy close in composition to René 41 [C 0.09, Cr 19, Co 11, Mo 10, Ti 3.1, Al 1.5, and B 0.005%]. Specimens were cast by induction and vacuum-arc methods and deformed to a total of 72.5%. The first two alloys had a higher impact strength and UTS than the last one, but they were inferior in respect to the creep resistance/ductility ratio during creep. The difference in properties is explained by the nature of the carbide precipitation. (Referativnyi Zh.)

734 STRUCTURE AND CERTAIN PROPERTIES OF ALLOYS BASED ON THE MOLYBDENUM–RHENIUM SYSTEM. Pikunov, M. V.; Danilina, T. B.; Mel'nikova, L. V.; Despri, A. I. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 22-8(1971). (In Russian).

A detailed metallographic study was made of the structure of Mo–50% Re–0.5% Fe alloys cast from an arc furnace using nonconsumable electrodes. A special method for the preparation and etching of sections was developed. Depending on its heat treatment, this alloy can be either single- or two-phase, with consequent variations in properties. Physical heterogeneities of the billets exist, e.g., marked differences in dendritic structure, that are associated with the solidification conditions. As a result, various parts of the structure show differences in hardness. Methods of deformation of this alloy, e.g., hot pressing and impact upsetting, were studied. (Referativnyi Zh.)

735 SOME FEATURES IN THE PLASTIC DEFORMATION OF MOLYBDENUM WITH A TWO-PHASE STRUCTURE. Statkevich, V. N.; Gaidarenko, A. L. Tekhnol. Legkikh Splavov, Nauch.-Tekh. Byul. VILSa; No. 1, 57-61(1970). (In Russian).

Optical microscopy was used to compare the plastic deformation behavior, at 1.0 mm/min, of pure Mo with that of an electron-beam melted Mo alloy containing Ti 0.02 to 0.03, C 0.07 to 0.09%, and Mo_2C particles. With the pure Mo traces of slip appeared close to the grain boundaries and led to intergranular fracture with deformations <0.50%. With the alloy the first traces of plastic deformation occurred in individual grains with stresses 3 to 5 kg/mm^2 below the 0.2 PS = 41-43 kg/mm^2. Fracture of the two-phase alloy, of the intragranular type, occurred after appreciable deformation. The increased ductility of Mo in the presence of carbides was due to a number of factors. (Referativnyi Zh.)

736 DIFFUSION OF SULFUR INTO THORIATED NICKEL. Hotzler, R. K. (Queensborough Community Coll., Bayside, N. Y.); Castleman, L. S. Met. Trans.; 3: No. 10, 2561-4(Oct 1972).

The diffusion of sulfur-35 into thoriated nickel has been studied by means of a surface intensity decrease technique. It was found that the kinetics of diffusion in the temperature range 925 to 1150°C can be expressed in terms of an apparent activation energy of about 38,000 cal/mole; this is markedly lower than the activation energy for lattice diffusion of sulfur-35 into unalloyed nickel, which is about 90,000 cal/mole. The results support the conclusion that more than one diffusion mechanism is involved, most probably lattice and grain boundary diffusion. (auth)

737 DEFORMATION OF POLYCRYSTALLINE ZIRCONIUM. Tiwari, S. N.; Lloyd, D. J.; Tangri, K. (Univ. of Manitoba, Winnipeg). Met. Trans.; 3: No. 10, 2605-12(Oct 1972).

The deformation of polycrystalline zirconium has been examined in terms of the power-law and the thermally activated rate equation approach to deformation. It was found that the thermal components of the flow stress is independent of strain and that the athermal component is the main contributor to work hardening. The deformation behavior is in general agreement with Fleischer's force-distance diagram for tetragonal defect-dislocation interaction. Electron microscopy however, showed that the majority of slip activity occurred on the prism planes and interstitials in octahedral positions do not interact strongly with dislocations on the prism planes. It is therefore suggested that deformation is controlled by solute atoms interacting with the dislocation core and

that this interaction has a force-distance relationship equivalent to that suggested by Fleischer. (auth)

738 MECHANISM OF VOID FORMATION, VOID GROWTH, AND TENSILE FRACTURE IN AN ALLOY CONSISTING OF TWO DUCTILE PHASES. Greenfield, M. A. (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Margolin, H. Met. Trans.; 3: No. 10, 2649-59(Oct 1972).

An investigation has shown that it is possible to relate void formation, void growth, and tensile ductility to microstructural features in an $\alpha-\beta$ titanium alloy, Ti–5.25 Al–5.5 V–0.9 Fe–0.5 Cu, heat treated to a constant yield strength. Equations relating tensile void growth rates to microstructure for both equiaxed, E, and Widmanstätten plus grain boundary α, W + G.B., in aged β morphologies have been derived. A mechanism for void formation at $\alpha-\beta$ interfaces is presented which accounts for the observed fact that voids do not form at Widmanstätten α platelets. Tensile fracture was found to be intergranular in nature and occurs when a critical crack length-stress relationship is satisfied. The amount of ductility achievable in a specimen depends upon the rate of void growth. If the rate is large, the void reaches a critical size for fracture at a lower applied stress and strain and hence the ductility is less. (auth)

739 SYMPOSIUM ON REFRACTORY METALS. PART I. Spring Meeting of the Metallurgical Society of AIME, Atlanta, Georgia, May 17–21, 1971. Met. Trans.; 3: No. 7, 1681-1748 (Jul 1972). (CONF-710557–(Pt.1)).

Nine papers were presented in Part I of the Symposium. A separate abstract was prepared for each of eight papers. The paper for which no abstract was prepared is concerned with properties of Cr-base alloys. (J.R.D.)

For abstracts of individual sections see: 625 and 740–746.

740 THERMODYNAMICS AND PHASE RELATIONS IN REFRACTORY METAL SOLID SOLUTIONS CONTAINING CARBON, NITROGEN, AND OXYGEN. Fromm, Eckehard; Jehn, Hermann (Univ. of Illinois, Urbana). Met. Trans.; 3: No. 7, 1685-92(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The refractory metals Nb, Ta, Mo, and W dissolve C, N, and O by forming interstitial solid solutions. The concentration of these components can be increased or decreased by annealing treatments, depending on the partial pressure of gases such as N_2, O_2, H_2O, CH_4, or CO and on the temperature of the specimen. New results in binary and ternary systems combined with those obtained in the last few years now provide most of the data needed for the thermochemical analysis of the solid solution phases and for the establishment of p-T-c phase diagrams. The mechanisms of the gas-metal reactions and the general feature of the constitution diagrams are similar for all refractory metals. However, marked differences exist between group Va metals niobium and tantalum and group VIa metals molybdenum and tungsten in the absolute values and temperature dependence of the equilibrium pressure of gaseous species and therefore also in the amount of gas absorbed. The data now available for the estimation of the final content of interstitials in solid solution after annealing treatments are compiled and discussed. (auth)

741 RELATIVE STABILITIES OF $Cr_{23}C_6$, Cr_7C_3, AND Cr_3C_2 AND THE PHASE RELATIONSHIPS IN TERNARY Cr–Mo–C SYSTEM. Chang, Y. A.; Naujock, D. (Univ. of Wisconsin, Milwaukee). Met. Trans.; 3: No. 7, 1693-8(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The thermodynamic properties of $CrC_{\frac{1}{2}}$, $CrC_{\frac{1}{3}}$, $CrC_{\frac{1}{4}}$, and $MoC_{\frac{1}{2}}$ reported in the literature have been correlated with the relative stabilities of these carbide phases derived from ternary phase diagrams. On the basis of the free energy of formation for one of the carbides and the free energy changes for the various equilibria occurring in ternary Mo–Cr–C system at 1300°C, free energies of formation for the stable and unstable carbide phases have been obtained. Using this free energy data, a calculated ternary Mo–Cr–C phase diagram is presented which agrees well with the experimentally determined one. (auth)

742 ELECTRON MICROSCOPY STUDY OF CARBIDE PRECIPITATION IN VANADIUM. Diercks, D. R.; Wert, C. A. (Univ. of Illinois, Urbana). Met. Trans.; 3: No. 7, 1699-1708 (Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The precipitation of carbon from supersaturated solid solution in vanadium has been investigated using transmission electron microscopy techniques on thin foils. High purity vanadium strip was doped to a carbon content of about 0.2 at.% and rapidly quenched in high vacuum, followed by aging treatments for various times in the temperature range from 300 to 600°C. The strip was then thinned for transmission electron microscopy. The carbon is observed to precipitate initially as very finely dispersed carbides visible through structure factor contrast. With increasing aging the precipitate distribution coarsens, and the carbides appear as very thin coherent platelets on {310} planes, showing a pronounced displacement fringe contrast. The coherent precipitate appears to have a bcc structure closely related to that of the matrix. With further aging these platelets are observed to thicken and partially lose coherency, punching out prismatic dislocation loops and helices having axes in ⟨111⟩ directions. This semicoherent precipitate is found to be the hexagonal V_2C phase described by other researchers, and its orientation relationship with the matrix may be expressed: $(110)_V||(00.1)_{V_2C}$, $[\bar{1}11]_V||[\bar{1}\bar{1}0]_{V_2C}$. The dislocation loops are a result of the specific volume difference between the V_2C precipitation and the matrix, and have Burgers vector b = a/2⟨111⟩. (auth)

743 REEXAMINATION OF VANADIUM FOR ALLOTROPY. Westlake, D. G.; Ockers, S. T.; Mueller, M. H.; Anderson, K. D. (Argonne National Lab., Ill.). Met. Trans.; 3: No. 7, 1711-13 (Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The possibility of allotropy in vanadium at subambient temperatures has been investigated by measuring electrical resistivity in the [110] direction of a single crystal, by measuring elastic constants, and by x-ray diffractometry. All studies indicated no allotropy. (auth)

744 RELATION BETWEEN HYDROGEN EMBRITTLEMENT AND THE FORMATION OF HYDRIDE IN THE GROUP V TRANSITION METALS. Owen, C. V.; Scott, T. E. (Ames Lab., Iowa). Met. Trans.; 3: No. 7, 1715-26(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The embrittlement of vanadium and tantalum by hydrogen has been investigated with the ultimate goal being to answer three specific questions concerning ductility behavior in different temperature ranges. Torsion pendulum internal friction and another technique using the torsion pendulum as well as visual observations have been used to establish the solid solubility curve in the V–H and the Ta–H systems. The primary variables studied in this work were tensile strain rate, test temperature and hydrogen content. The results have been analyzed and tentative hypotheses have been set forth to explain the ductility behavior of the hydrogen charged metals. (auth)

745 ANALYSIS OF PRIMARY CREEP OF MOLYBDENUM AT HIGH TEMPERATURES. Ericksen, R. H.; Jones, G. J. (Sandia Labs., Albuquerque, N. Mex.). Met. Trans.; 3: No. 7, 1735-41(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The high temperature creep behavior of polycrystalline molybdenum was investigated at 1720°C using constant stress tests in an ultra-high vacuum environment. The strain dependence of the dislocation substructure was examined using etch pit techniques and transmission electron microscopy. Subboundaries were formed early in the transient region of the creep curve, and the details of this substructure development are presented. Grain growth occurred during testing, and this phenomena is discussed in terms of deviations from parabolic time law behavior. Various time laws were applied to the data and the Li equation was found to give the best fit. This equation was subsequently used to evaluate a model for dislocation remobilization. (auth)

746 EFFECT OF LOW-PRESSURE OXYGEN ON THE CREEP PROPERTIES OF W–25 PERCENT Re. Inouye, H.; Wagner, R. L. (Oak Ridge National Lab., Tenn.). Met. Trans.; 3: No. 7, 1743-8(Jul 1972).

From Spring meeting of the Metallurgical Society; Atlanta, GA. (17 May 1971). See CONF-710557–(Pt.1).

The creep properties of W–25% Re were measured in low-pressure oxygen to simulate its interaction with oxygen derived from the decomposition of oxides at high temperatures. The results are compared with the creep properties of the alloy in a vacuum of 10^{-7} torr. Between 1650 and 2000°C and stresses of 1000 and 2000 psi, the creep rates were lower in 10^{-5} torr O_2 than in vacuum by factors as high as 250; however, rupture strains were only 2 to 7% in the O_2 environment. Specimens exposed to oxygen before creep testing in vacuum were also stronger than specimens tested in vacuum. The oxygen content of specimens tested in oxygen was generally lower than in the

as-received material. The lower creep rates of W-25% Re in oxygen are attributed to the presence of a surface layer of σ phase. This reaction layer results from the formation of volatile tungsten oxides at a higher rate than rhenium oxides. (auth)

747 MUTUAL SOLUBILITIES OF TITANIUM AND BORON IN PURE ALUMINUM. Finch, N. J. (British Non-Ferrous Metals Research Association, London). Met. Trans.; 3: No. 10, 2709-11(Oct 1972).

The mutual solubilities of Ti and B in Al–Ti–B ternary melts were determined over the temperature range 700 to 1300°C, and the results interpreted in terms of the assumption that the solubilities of these elements are limited by their reaction together to form TiB_2 probably containing aluminum diboride. The results were partial confirmation of the assumption that Ti and B are mainly present as diboride, rather than, for example, a mixture of $TiAl_3$ and AlB_2. The amounts of Ti and B coprecipitated indicate a solid solution or mixture of TiB_2 and excess boron presumably as AlB_2. It was also indicated that melts become saturated with respect to TiB_2 at very low concentrations of Ti and B. For example at 1300°C the solubility limit was 0.035% Ti, 0.016% B, equivalent to 0.051% TiB_2. (P.C.H.)

748 ENTHALPY OF MOLYBDENUM AND TANTALUM FROM 298 TO 1400K. Oetting, Franklin L.; Navratil, James D. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Chem. Eng. Data; 17: No. 2, 230-1(Apr 1972). (RFP–1729).

High-temperature enthalpies from 298 to 1400°K for molybdenum and tantalum have been determined by a copper block drop calorimeter of the isoperibol type. Agreement between these experimental results and certain compilations in the literature is satisfactory. (auth)

749 TUNGSTEN COATING OF CERAMICS BY REDUCTION OF WS_2. Cech, R. E. Met. Trans.; 3: No. 7, 2004-5(Jul 1972).

A new procedure for deposition of tungsten coatings on ceramics is described. The ceramic part is burnished with dry tungsten disulfide powder using a soft material such as cork as the applicator. This action causes a dense, continuous coating of the compound to be formed on the ceramic. X-ray examination of the coating shows it to be highly oriented crystallographically with the hexagonal basal plane parallel to the surface. The coated part is then treated in dry hydrogen at 680 to 700°C to reduce the coating to metallic tungsten. The reduction step can be markedly accelerated (to ~20 min at 700°C) by coating the surface with calcium hydride or hydroxide powder before the reduction treatment. The coating produced in this manner contains about 0.25 mg W/cm^2 exhibiting a room temperature resistance of ~500 ohms/cm^2. (J.R.D.)

750 SURFACE TENSIONS OF INDIUM AND CADMIUM. White, D. W. G. (Dept. of Energy, Mines, and Resources, Ottawa). Met. Trans.; 3: No. 7, 1933-6(Jul 1972).

The surface tensions of 99.9999% In and Cd have been measured by the sessile drop method. The surface tension/temperature behavior of liquid indium is nonlinear and within a certainty of 99.5% can be represented by the following quadratic equation: $\gamma_{In} = 568.0 - 0.04t - 7.08 \times 10^{-5}\ t^2 \pm 5$ dyne per cm. At its melting point, the surface tension of liquid indium is 560 ± 5 dyne per cm. The slope of the temperature coefficient of the surface tension of liquid cadmium is strongly positive at the melting point, becomes zero about 100°C above the melting temperature (at which point the surface tension is a maximum), and is negative at higher temperatures. At the melting point, the surface tension of cadmium is 590 ± 5 dyne per cm. The surface tension of cadmium is not as readily affected by nonequilibrium thermal conditions as is the surface tension of zinc. The form of the surface tension/temperature curve of indium and cadmium together with similar data for Zn, Cu, Pb, and Sn support a theoretical scheme which generalizes liquid metal surface tension behavior and which, on the basis of calculations, lists liquid metals according to their propensity for surface ordering. (auth)

751 EFFECTS OF COMBINED HIGH AND LOW TEMPERATURE DEFORMATION PROCESSING OF β III TITANIUM. Roberson, J. A.; Adair, A. M. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Met. Trans.; 3: No. 7, 1967-72 (Jul 1972).

The structure and properties of β III titanium alloy (nominal composition: 11.5% Mo, 6% Zr, 4.5% Sn, bal Ti) were studied as a function of combined high and low temperature thermomechanical processing. A water quenched extrusion was deformed various amounts by swaging at room temperature prior to the aging treatment. No re-solution heat treatment was employed. The swaging introduced mechanical twinning and a small amount of stress induced orthorhombic martensite. Following a 900°F, 8 h aging treatment, substantial increases in yield and tensile strength were observed, combined with a severe decrease in tensile ductility in samples with small amounts of swaging. The orientation and morphology of the deformation products have a critical influence on tensile ductility. A decrease in the plane strain fracture toughness accompanied the large increase in tensile strength. (auth)

752 ANOMALOUS STRUCTURES IN EUTECTIC ALLOYS. Chell, M. F.; Kerr, H. W. (Univ. of Waterloo, Ont.). Met. Trans.; 3: No. 7, 2002-4(Jul 1972).

Results of investigations are presented which indicate that the anomalous structures observed in undercooled Ni–^{3}Sn and Ag–^{4}Cu eutectics solidified in the same way as that observed in monovariant Pb–Sn–Cd alloys, i.e., by the growth of frequently branching two-phase dendrites. In the Pb–Sn–Cd alloys, lamellar structures were only found in the central cores of some stalks and branches of the two-phase dendrites, where presumably the necessary growth directions and habit planes were satisfied. Growth in other directions resulted in irregular structures since the phases were then relatively unconstrained by crystallographic factors. Such irregular structures are favored by fast growth rates or high solute contents. Both of these factors decrease the dendrite tip radius, thus preventing the growth of a significant number of parallel lamellae. (auth)

753 THERMAL CONDUCTIVITY OF LIQUID METALS AND ALLOYS. Viswanath, D. S.; Mathur, B. C. (Indian Inst. of Science, Bangalore). Met. Trans.; 3: No. 7, 1769-72(Jul 1972).

The thermal conductivity data of liquid metals have been correlated based on the cell theory of liquids. The temperature dependence of thermal conductivity is predicted in the case of thirteen metals for which experimental data are available. The overall average absolute deviation of predicted values is 4.25%. The method has been extended to alloys. (auth)

754 STRUCTURE AND PROPERTIES OF THERMOMECHANICALLY TREATED β–III TITANIUM. Kalish, D. (Bell Telephone Labs., Inc., Norcross, Ga.); Rack, H. J. Met. Trans.; 3: No. 7, 1885-92(Jul 1972).

Beta-III titanium (Ti-11.5 Mo–5.5 Zr–4.5 Sn) was solutionized above the β-transus, water-quenched and deformed by rolling at room temperature. The deformation accelerated the aging kinetics at all temperatures up to the β transus. The thermomechanically treated (TMT) alloy always had higher strength than the conventionally heat treated (CHT) alloy; the effect being most marked when the aging product was normally α in a β matrix. In addition, the ductility and notched impact resistance of TMT β–III was greater than that of the CHT alloy in the overaged condition. The TMT did not alter the morphology of the ellipsoidal α phase formed at low aging temperatures and short aging times, respectively. Here the strengthening increase is attributed to strain hardening of the initial $\beta + \omega$ microstructure. The deformation did substantially change the morphology of the Widmanstätten α phase that formed at higher aging temperatures. In particular, the Widmanstätten α plates were much finer and the β grain boundaries were no longer a preferred precipitation site following TMT. At the highest aging temperatures, the TMT material developed a cell structure of about 1 μ in diameter. (auth)

755 EFFECTS OF ENVIRONMENT ON THE ELEVATED TEMPERATURE FATIGUE BEHAVIOR OF NICKEL-BASE SUPERALLOY SINGLE CRYSTALS. Duquette, D. J. (Pratt and Whitney Aircraft, Middletown, Conn.); Gell, M. Met. Trans.; 3: No. 7, 1899-1905(Jul 1972).

The effects of air and vacuum on the fatigue behavior of a nickel-base superalloy, Mar-M200, in single crystal form were investigated. Between 800 and 1400°F fracture is entirely in the Stage I mode in air and vacuum, and fatigue life is unaffected by environment. At 1700°F in both environments, fracture is predominantly in the Stage II mode and fatigue life in air is greater than that in vacuum. At both temperatures, fatigue cracking in air is internally initiated, whereas in vacuum cracking is generally initiated at the specimen surface. Identical fatigue lives in air and in vacuum between 800 and 1400°F are attributed to the fact that internally initiated cracks in air are actually propagating in a high vacuum, surface cracking being inhibited by dynamic oxidation of emerging surface slip offsets. The subsurface portion of the Stage I fracture surface produced in air tests and all of the Stage I fracture produced in vacuum tests shows a dimpled structure, whereas the Stage I fracture surface produced while the crack propagation is in air shows a cleavage appearance. At 1700°F, bulk oxidation of surface initiated cracks interferes with the plastic blunting mechanism of Stage II crack growth normally observed at this temperature, internally initiated cracks causing ultimate failure. Shorter lives in vacuum are thought to result from enhanced Stage II surface crack propagation. (auth)

756 INTERNATIONAL SYMPOSIUM ON ZIRCONIUM ALLOYS, MONTREAL, QUEBEC, AUGUST 31–SEPTEMBER 1, 1971. Can. Met. Quart.; 11: No. 1, 1-277(1972). (CONF-710821).

Twenty-seven papers are included; a separate abstract was prepared for each. The papers are grouped under the main classifications of corrosion, deformation, tubing properties, and alloy development. (P.C.H.)

For abstracts of individual papers see: 680–682, 702, 757–775, and 846–849.

757 DEFORMATION AND FRACTURE OF ALPHA ZIRCONIUM ALLOYS. Jensen, J. A.; Backofen, W. A. (Massachusetts Inst. of Tech., Cambridge). Can. Met. Quart.; 11: No. 1, 39-51 (1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The deformation and fracture of Zircaloy-4 and pure zirconium sheets having strong (0002) textures were studied under plane-strain compression at temperatures from 20 to 800°C. Zircaloy-4 underwent a ductility transition from limited strain (0.1 to 0.3) to extensive fracture-free flow (>0.6) at about 300°C; pure zirconium was ductile at all temperatures. These differences were traced to others in deformation mechanisms. Below 300°C, Zircaloy-4 accommodated compression along [0001] by ⟨c + a⟩ slip; these dislocations were mainly confined to thin bands oriented close to $\{11\bar{2}4\}$. In pure zirconium $\{11\bar{2}2\}$ twinning followed by second- and third-order retwinning tended to distribute strain more uniformly. Above 300°C both materials deformed by a combination of $\{10\bar{1}1\}$ twinning and ⟨c + a⟩ slip. Fracturing in Zircaloy-4 was by highly localized shear along thin bands of $\{11\bar{2}4\}$ orientation. From an analysis based on measured strain-hardening behavior and standard heat flow equations, it is suggested that localized shear can be brought about by thermal softening during slip-band formation. (auth) (Canada)

758 SOME OBSERVATIONS OF DUCTILE VOID GROWTH AND CRACK PROPAGATION IN ALPHA ZIRCONIUM. Watson, D.; Warren, M. R.; Beevers, C. J. (Univ. of Birmingham, Eng.). Can. Met. Quart.; 11: No. 1, 53-9(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Tensile tests were carried out on zirconium at 77°K to study the effects of unloading on ductile crack propagation and at 77, 295, and 423°K to examine the influence of matrix deformation characteristics on void growth rates. The effects of unloading were considered in terms of the relaxation at the crack tips and estimates of the increased work necessary to propagate such relaxed cracks were consistent with the observed increases in fracture stress. The process of void growth was studied metallographically and changes in void dimensions were measured as a function of specimen strain. These studies indicate that the strain increments at the void tips are most important in the void growth process and that the void growth rate increases with increasing deformation temperature. (auth) (Canada)

759 GRAIN SIZE DEPENDENCE OF THE DEFORMATION BEHAVIOUR OF ALPHA ZIRCONIUM. Ramani, S. V.; Rodriguez, P. (Bhabha Atomic Research Centre, Bombay). Can. Met. Quart.; 11: No. 1, 61-7(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The influence of grain size on the deformation behavior of α-zirconium in the temperature range 77 to 443°K was investigated. The flow stress variation with grain size followed the Hall–Petch equation $\sigma = \sigma_i + Kd^{-\frac{1}{2}}$. Work hardening was found to increase with decrease in grain size; also for any grain size and strain, the rate of work hardening decreased with increasing temperature. Analysis on the basis of the work-hardening equation $\sigma = \sigma_0 + h\,\epsilon_p^m$ revealed more than one stage of work hardening for all grain sizes and temperatures. The work hardening behavior and its temperature dependence can be explained on the basis of cross slip occurring with ease at lower strains at higher temperatures and the consequent difference in dislocation density and arrangement for the same strain at different temperatures. The nature of slip character and dislocation arrangement also modified the grain-size dependence of flow stress. Ability to cross slip leading to a cellular arrangement of dislocations at lower strains as the temperature was increased, gave rise to lower values of K and a smaller dependence of K on strain at higher temperatures. (auth) (Canada)

760 INTERNAL FRICTION STUDIES IN DILUTE ZIRCONIUM ALLOYS. Mishra, S.; Asundi, M. K. (Bhabha Atomic Research Centre, Bombay). Can. Met. Quart.; 11: No. 1, 69-77(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Internal friction studies on zirconium and dilute zirconium alloys containing the interstitial impurities oxygen and nitrogen have indicated that the internal friction is caused by an interaction of substitutional and interstitial atoms. For all the alloying elements, oxygen gave two peaks, the relative intensity depending upon the concentration of oxygen. At low oxygen contents, the high temperature peak was the more prominent and was due to three oxygen atom jumps. At high oxygen concentrations, the low temperature peak was the more prominent and was due to a single oxygen jump. In the case of nitrogen, only alloying element larger in atomic size than zirconium gave internal friction peaks, the mechanisms being similar to those for oxygen. (auth) (Canada)

761 SOLUTE STRENGTHENING AT HIGH TEMPERATURES IN ZIRCONIUM-TIN ALLOYS. Luton, M. J.; Jonas, J. J. (McGill Univ., Montreal). Can. Met. Quart.; 11: No. 1, 79-90(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Polycrystalline samples of alpha zirconium and a series of zirconium–tin alloys containing 0.7, 3.0, and 5.0% Sn were tested between 625 and 925°C and at strain rates of 10^{-4} to 1 s^{-1}. The yield values were determined by an offset method, and were observed to be strongly temperature- and strain-rate sensitive. They obeyed an empirical power law at the higher temperatures and lower strain rates. At the lower temperatures and higher strain rates, the power law broke down, and the flow stress was nearly independent of strain rate and temperature, indicating a shift to athermal deformation. Activation analysis of the experimental data led to activation areas which decreased rapidly with stress from about 1000 to about 100 b^2. The yield stresses increased markedly with tin concentration, but the activation areas varied only slightly with tin content and did not follow a $c^{\frac{1}{4}}$ law. The analysis indicated that solute atoms do not constitute obstacles to flow, and that instead the thermally activated event controlling the deformation is likely to be the breakup of attractive junctions. The width of the local obstacles increased with tin concentration, probably as a result of the decrease in stacking fault energy produced by alloying. The major strengthening effect of tin was associated with an increase in height of the local obstacles. This was deduced from the increase in experimental activation energy with tin concentration and was attributed to the increased stability of the attractive junctions as the stacking fault energy was decreased. (auth) (Canada)

762 STRAIN RATE DEPENDENT HARDENING IN ZIRCONIUM AND ZIRCONIUM-NIOBIUM ALLOY. Lee, D. General Electric Research and Development Center, Schenectady, N. Y.). Can. Met. Quart.; 11: No. 1, 113-7(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The strain-rate dependent hardening behavior of commercial-grade purity zirconium and its alloy containing 2.5 wt% niobium was investigated by employing a stress relaxation testing method at temperatures from room temperature to 400°C. It was demonstrated that a complete phenomenological description of the mechanical behavior could be obtained by representing the stress-strain rate relationship in terms of the temperature, strain and microstructure. At low temperatures, the flow stress (σ) and strain rate ($\dot{\epsilon}$) were related so that the rate sensitivity index $m = \partial \ln\sigma / \partial \ln\dot{\epsilon}$ remained constant over a wide strain rate range. Moreover, an addition of 2.5 wt% niobium in pure zirconium resulted in the strength increase of about 60,000 psi, which was independent of strain rate. When the temperature was increased to 400°C, the value of m began to increase rapidly, but the effectiveness of strengthening by niobium diminished with decreasing strain rate. These variations in the stress-strain rate relationship with temperature could in part be rationalized on the basis of the relative contributions of the strain rate dependent and independent hardening processes. (auth) (Canada)

763 DEVELOPMENT OF TEXTURE AND STRUCTURE IN Zr–2.5 WT. PERCENT Nb EXTRUDED TUBES. Cheadle, B. A.; Aldridge, S. A.; Ells, C. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 121-7(1972). (AECL-4234).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Factors that affect the texture and microstructure of Zr–2.5 wt% Nb extruded tubes were investigated. The major factor that determines the texture is the way the metal flows, which is controlled by the die shape, the extrusion ratio, and the lubricant. The microstructure is controlled by the temperature during extrusion and the cooling rate afterwards. (auth) (Canada)

764 HYDRIDE ORIENTATION AND TENSILE PROPERTIES OF Zr–2.5 WT. PERCENT Nb PRESSURE TUBING HYDRIDED WHILE INTERNALLY PRESSURIZED. Price, E. G. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). Can. Met. Quart.; 11: No. 1, 129-38(1972). (AECL-4241).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

An investigation was carried out to determine the orientation and the effects on tensile properties of hydrides precipitated in heat-treated Zr–2.5 wt% Nb tubing during the corrosion hydriding of internally pressurized samples. It was found that as the stress during hydriding was increased the hydrides gradually assumed a characteristic radial orientation nearly perpendicular to the hoop stress. The observed radial hydride orientation was influenced by prior β grain size, residual quenching stresses, cold-work strains and stresses applied while the pressure tube was being hydrided. Hoop stresses in excess of 20,000 psi were required to produce complete radial orientation of the hydrides. Transverse tensile tests on the hydrided tubes were conducted using a reduced section ring technique. These tests revealed a low ductility at low temperatures with a transition in the range 60 to 100°C for material with radially oriented hydrides. Low tensile ductility was observed at significantly higher temperatures when a massive hydride layer was present near the surface of the test samples. (auth) (Canada)

765 EMBRITTLEMENT OF HEAT-TREATED Zr–2.5 WT. PERCENT Nb PRESSURE TUBES. Pickles, B. W. (United Kingdom Atomic Energy Authority, Culcheth). Can. Met. Quart.; 11: No. 1, 139-46(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Fracture studies were made on two batches of SGHWR pressure tubing. One of the batches had a normal grain size and structure, while the other was coarse grained due to overheating during heat treatment. The aim was to determine the critical crack length of the tubes under reactor operating conditions, and the effects on the critical lengths of embrittlement by hydrogen absorption and neutron irradiation damage. Tubes were measured directly where possible, while supplementary data were obtained from tests on small specimens, enabling the effects of embrittlement to be predicted. The coarse-grained tube was found to be much more susceptible to hydrogen and irradiation embrittlement than the fine-grained tube, and it is expected that the critical length would be reduced from an initial 4 in. to about 1.5 in. at the end of life. In contrast the critical length of the fine-grained material would only be reduced from 5 in. to approximately 3.5 in. (auth) (Canada)

766 EFFECT OF THERMAL CYCLING ON THE STRESS ORIENTATION AND CIRCUMFERENTIAL DUCTILITY IN ZIRCALOY-2. Mishima, Y.; Okubo, T. (Tokyo Univ.). Can. Met. Quart.; 11: No. 1, 157-64(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The radial orientation of hydride in Zircaloy tubing reportedly causes a marked decrease in the circumferential ductility. Zircaloy cladding tubes used in power reactors today are fabricated under conditions controlled so that hydrides in the tube are circumferentially oriented. Applied stress during the precipitation of hydride under cooling affects the orientation in experiments on stress reorientation but the effect of stress has been investigated during only one thermal cycle. In reactor, however, cladding encounters repeated thermal cycles between operating temperature and room temperature. The effects of thermal and stress cycles on the orientation of hydride, simulating reactor operation, were investigated. After 30 thermal cycles without an applied stress, the hydride orientation did not change, but the length of the hydride platelet depended on the cooling rate. A cooling rate of 80°C/h caused a decrease in hydride size with repeated cycles. The effect of stress was not significant up to 10 kg/mm^2. Hydride size decreased with increasing number of cycles with an applied stress of 20 kg/mm^2 and radially oriented hydrides increased. The circumferential ductility of Zircaloy-2 tubing subjected to the thermal cycling was measured by flare and flattening tests. Generally, ductility at room temperature was low and increased with increasing temperature. At a high hydrogen concentration of 1000 ppM, ductility at room temperature was zero, whereas at 300°C, the ductility was similar to that of the lowest hydrogen specimen. At a stress of 20 kg/mm^2, one and five thermal cycles caused a decrease in ductility. (auth) (Canada)

767 EFFECT OF OXYGEN AND FABRICATION VARIABLES ON THE MECHANICAL PROPERTIES OF ZIRCALOY TUBING. Konishi, T.; Matsuda, K.; Teranishi, H. Sumitomo Metal Industries, Ltd., Amagasaki). Can. Met. Quart.; 11: No. 1, 165-75(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The effects of oxygen concentration and fabrication variables on the mechanical properties of Zircaloy-2 tubing were investigated. The strength can be adjusted with a small loss of ductility by controlling oxygen concentration. Cold reduction in the range of this study has a large effect on recrystallization and ductility but little on texture. The Q value, the ratio of the wall thickness reduction to the diameter reduction during fabrication, has a significant effect on texture, hydride orientation, and deformation behavior. Tubes produced with a high Q value possess a superior combination of strength and ductility than tubes produced with a low Q value. In burst testing, axial contraction contributes greatly to the circumferential elongation due to the difficulty of thickness reduction in high-Q tubes. In low-Q tubes, both thickness reduction and axial contraction, which is smaller than that in high-Q tubes, contribute to the circumferential elongation. In practice, the optimum fabrication conditions for each fuel design must be determined. (auth) (Canada)

768 YIELD LOCI OF ZIRCALOY TUBING WITH DIFFERENT TEXTURES. Dressler, G.; Matucha, K. H.; Wincierz, P. (Metallgesellschaft AG, Franfurt am Main). Can. Met. Quart.; 11: No. 1, 177-84(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Yield loci of four batches of Zircaloy-4 canning tubes with different textures were measured at room temperature for quadrants I and IV (axial tensile or compressive stresses in combination with internal pressure). The circumferential and axial strains were continuously recorded using applied strain gauges and maximum plastic strains of about 0.2%. A comparison with the yield loci determined by Knoop hardness measurements gave marked differences in the shape of the yield loci. The experimental results showed that the shape of the yield loci of Zircaloy tubing can be altered by texture variations, mainly by changes in the tilt angle of the basal poles of the hexagonal zirconium crystals from the radial towards the tangential direction of the tubes. The yield loci of tubes with a sharp ideal orientation can be calculated successfully for all four quadrants on the basis of the active slip or twinning systems for specific biaxial loading conditions. It was found that the use of the Von Mises yield criterion is limited to only a few texture and stress conditions. (auth) (Canada)

769 TEXTURE AND ANISOTROPY OF ZIRCONIUM IN RELATION TO PLASTIC DEFORMATION. Kaellstroem, Krister (Sandvick Steel Works, Sweden). Can. Met. Quart.; 11: No. 1, 185-98(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Possible modes of plastic deformation of tubular materials were analyzed generally. Based on symmetry considerations applied to known textures of zirconium wire and strip, textures of zirconium tubes were predicted as resulting from a wide range of deformation modes. This was made possible by focusing on the main feature of texture, i.e., the orientation distribution of basal poles. A relation between texture and the mechanical anisotropy of zirconium was developed, and rules are suggested for softening and hardening caused by texture change. Experimentally, Zircaloy tubes were deformed by various techniques. The resulting textures were determined by x-ray diffraction and the mechanical anisotropy by Knoop-hardness measurement. Each determination was condensed into two representative figures, one describing the type of texture or anisotropy and the other describing the sharpness of texture or the degree of deviation from anisotropy. The experiments verify the predicted relation between type of texture and mechanical anisotropy, and also indicate how degree of anisotropy depends on sharpness of texture. Changes in texture were investigated in relation to plastic deformation, and further refined rules were derived for the direction and rate of these changes. The initially predicted textures were concluded to be stable, i.e., they were reached only after a certain degree of deformation. Zircaloy tubes of three different textures were subjected to tensile testing, closed-end burst testing, and open-end burst testing. The observed texture-softening phenomenon corroborated the rules suggested and was considered to commonly occur, as opposed to texture hardening, which requires special combinations of texture and testing method. (auth) (Canada)

770 TRANSFORMATION IN ZIRCONIUM–NIOBIUM ALLOYS. Hehemann, R. F. (Case Western Reserve Univ., Cleveland). Can. Met. Quart.; 11: No. 1, 201-11(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The transformations that occur in Zr alloys containing 10 to 50% niobium are discussed. The principal reactions observed

were: the formation of α by a classical martensitic reaction and as a diffusion-controlled promonotectoid constituent; the formation of ω in a diffusionless, but non-martensitic manner during quenching and in a diffusion-controlled manner during aging; and segregation required by the solubility gap which can occur as a cellular reaction at high temperatures or by the formation of zirconium-rich Guinier–Preston zones at large supercooling. (auth) (Canada)

771 MICROSTRUCTURAL EXAMINATION OF STRAIN-INDUCED PHASE TRANSFORMATIONS IN SELECTED ZIRCONIUM ALLOYS. Northwood, D. O.; Rezek, J. (Univ. of Windsor, Ont.). Can. Met. Quart.; 11: No. 1, 213-21(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The stability with respect to deformation by rolling at ambient temperatures of the metastable β phase of zirconium alloys containing molybdenum, vanadium, niobium, tin, and aluminum was analyzed in terms of a stability diagram originally proposed for isomorphous titanium alloys. Molybdenum was found to be a very potent β stabilizer as was vanadium. Niobium appeared to be the least effective of the β stabilizers investigated. Aluminum and tin acted as α stabilizers: aluminum had a far greater effect than tin. Of the alloys investigated only a limited number showed any evidence of a strain-induced transformation of the metastable β phase to a martensitic α'_D phase. An alloy containing Zr–0.8 wt% Mo–2 wt% V–2 wt% Nb–2 wt% Sn was the most promising of these alloys and an investigation of its mechanical properties is proposed. (auth) (Canada)

772 MECHANICAL PROPERTIES AND STRUCTURE OF AS-RECEIVED HEAT-TREATED AND HYDRIDED Zr–1.5 WT. PERCENT Cr–0.1 WT. PERCENT Fe ALLOY TUBING. Slattery, G. F. (United Kingdom Atomic Energy Authority, Springfields). Can. Met. Quart.; 11: No. 1, 237-48(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The mechanical properties of both unhydrided and hydrided Zr–Cr–Fe alloy tubing have been evaluated using ring tensile, tube burst, and Charpy impact tests over a range of temperatures from room up to 400°C. Aspects of the recovery and recrystallization of two batches of tubing were studied. Stress relieving cold-worked tubing between 450 and 575°C gave stronger, less ductile material compared with recrystallized tubing but the actual tensile values depended critically on the stress-relieving temperature. Beta quenching and aging thin-walled tubing resulted in poor ductility, variable strength and structure with some massive grain coarsening. The tensile ductility of Zr–Cr–Fe tubing was lowered by circumferentially aligned hydride although the drop was not serious at least up to 400 ppM hydrogen. Hydride had little effect on tensile strength up to 300 ppM hydrogen but there was an increase in strength at higher hydrogen levels. (auth) (Canada)

773 PRECIPITATION REACTIONS IN Zr–2 AT. PERCENT Cr–0.16 AT. PERCENT Fe. Warren, M. R.; Ytterhus, J. A. (Danish Atomic Energy Commission Research Establishment, Risoe). Can. Met. Quart.; 11: No. 1, 249-56(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

The heat treatment which optimizes the corrosion resistance of Zr–2.0 at.% Cr–0.16 at.% Fe is a β quench and age at 760°C. Rumball and Coleman have shown that if the quench rate is in the range 3500 to 7500°C/s, the subsequent aging treatment leads to grain growth involving loss of strength and ductility. This work shows that aging in the temperature range 270 to 400°C induces precipitation prior to recrystallization, which may restrict grain growth at higher temperatures. The low-temperature precipitation is associated with two peaks, in the resistivity isotherms, which become progressively less pronounced, and occur at progressively shorter aging times as the aging temperature is raised. The precipitation process, involving the rejection of Cr and Fe from supersaturated solid solution, did not follow a simple rate law, but could be characterized by an activation energy of 0.93 ± 0.03 eV once equilibrium had been attained. Supplementary evidence showed that the resistivity peaks are probably associated with two distinct preprecipitates which may be compared to the θ' precipitate found in Al–Cu alloys. (auth) (Canada)

774 DEVELOPMENT OF HIGH STRENGTH ZIRCONIUM ALLOYS. Williams, C. D.; Ells, C. E.; Dixon, P. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 257-71(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Assessment of the effects of various alloying elements and strengthening methods in zirconium alloys has indicated that alloys with adequate strength for use as pressure tube material at temperatures above 400°C can be developed. Ternary, quaternary, and quinary alloys based on zirconium were prepared and subjected to various thermal and deformation treatments. Their age-hardening behavior and tensile properties are described and some information on their corrosion resistance and response to fast neutron irradiation at 300 and 450°C is presented. The target of UTS in the range 90 to 120 kpsi at 450°C can be achieved in alloys having an acceptable thermal neutron capture cross section. Adequate strength combined with the ductility necessary for pressure tube fabrication can be obtained by air cooling selected alloys from temperatures high in the ($\alpha + \beta$) range. (auth) (Canada)

775 CREEP AND STRESS-RUPTURE OF HIGH STRENGTH ZIRCONIUM ALLOYS. Ibrahim, E. F.; Price, E. G.; Wysiekierski, A. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 273-83(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Zirconium-based alloys with small additions of tin, molybdenum, niobium, and aluminum are being developed as candidate materials for high-strength pressure tubes in advanced CANDU reactors. The out-reactor creep and stress-rupture properties of 12 alloys based on these elements were determined and correlated with their metallographic structures and sub-structures and thermomechanical histories. An alloy of composition Zr–3 wt% Sn–1 wt% Mo–1 wt% Nb was the best for high creep strength, low neutron capture cross section, and reasonable corrosion resistance. (auth) (Canada)

776 IMPORTANCE OF MOLYBDENUM IN HEAVY STEEL SECTIONS. Henry, P. Molybdaen-Dienst; No. 78-79, 3-27 (1972). (In German).

A comprehensive report of mechanical and physical properties of steels containing molybdenum and their fields of application is presented. For the range of nuclear energy techniques molybdenum shows an absorption cross-section for thermal neutrons of 2.7 barns, which is comparable with the value for iron with 2.53 barns. The isotopes arising from irradiation of Mo have only a short half life. Materials containing molybdenum are described. (GF)

777 HEATS OF FORMATION OF SOLID INDIUM–LEAD ALLOYS. Yoon, Hong-il; Hultgren, Ralph (Lawrence Berkeley Lab., Calif.). J. Chem. Eng. Data; 17: No. 2, 176-7(Apr 1972). (UCRL–18402(Rev.)).

Heats of formation of solid indium–lead alloys at 315°K were determined by liquid tin solution calorimetry. The alloys formed endothermically, except, possibly, the In phase, where $\Delta H \sim 0$. Partial molar heats of solution of indium and lead in tin were also determined. (auth)

778 TEMPERING TEMPERATURE EFFECT ON PHASE TRANSFORMATIONS IN AS-CAST NICKEL–CHROMIUM ALLOYS CONTAINING NIOBIUM AND MOLYBDENUM. Ionkina, E. M.; Lebedev, K. P. Issled. Litein. Protsessov Splavov; No. 319, 114-19(1971). (In Russian).

Nickel-base cast alloys with 15% Cr and stabilized by Nb and Mo were investigated. The effects of the annealing temperature of the hardened alloys on the microstructure and hardness at room temperature were studied. Depending on the annealing temperature and the Nb content, alloy toughening in the Ni–15Cr–Nb system was explained by the separation of a second, hardening phase in a dispersed or acicular form. Additional amounts of Mo to 5, 10, and 15% in the Nb-containing alloy accelerated the decay process of the supersaturated Ni–Cr solution and the transition of a dispersed, metastable phase to an equilibrated acicular one. (tr-auth)

779 STRUCTURAL DISTRIBUTION OF TANTALUM IN YTTRIUM STUDIED BY CONTACT X-RAY MICROGRAPHY. Voskresenskaya, L. A.; Petukhova, A. S.; Pikunov, M. V. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 34-7(1971). (In Russian).

Contact x-ray micrography is eminently suitable for studying Ta distribution in samples of Yt prepared by various methods. In general Yt is appreciably contaminated with Ta. A study was made of the nature of its distribution and how it was affected by Cu and Fe impurities. (Referativnyi Zh.)

780 EFFECT OF TITANIUM ON THE CORROSION RESISTANCE AND PHYSICO-MECHANICAL PROPERTIES OF VANADIUM. Andreeva, V. V.; Stepanova, T. P.; Druzhinina, I. P.; Vladimirskaya, T. M. Nauch. Tr., Nauch.-Issled. Proekt. Inst. Redkomet. Prom.; 32: 175-81(1971). (In Russian).

Results are given from a study of the physical and mechanical properties, structure, corrosion resistance, and electrochemical

behavior of V–Ti alloys containing Ti 10 to 90%. (Referativnyi Zh.)

781 STRENGTH PROPERTIES OF WELDED JOINTS OF TITANIUM ALLOYS CONTAINING ISOMORPHOUS β-STABILIZING ELEMENTS. Khorev, A. I.; Gruzdeva, L. A. Svar. Proizv.; No. 8, 37-40(Aug 1971). (In Russian).

The results of a study on the effects of isomorphous β-stabilizing elements–molybdenum and vanadium, as well as molybdenum in conjunction with vanadium (given a constant α-stabilizing aluminum addition content of 3 percent) on the mechanical properties of the base metal and welded joints of titanium alloys are described. The vanadium was introduced in an amount conditionally equivalent to the effect of molybdenum (1 percent Mo equivalent to 1.5 percent V). For smelting of alloys use was made of TG 105 titanium sponge, AOO aluminum, aluminum–molybdenum master alloy, molybdenum powder, and high-purity vanadium. It was found that alloys containing vanadium of electrolytic purity have a lower strength than those alloyed with molybdenum, while those alloyed simultaneously with molybdenum and vanadium take an intermediate position with respect to strength. An attempt was made to classify weldable titanium alloys according to mechanical properties and degrees of alloying with β-stabilizing elements. There is a zero group containing α-alloys unalloyed with β-stabilizing elements (Ti-3Al alloy; commercial unalloyed VT1-00, VT1-0, VT1 titanium; alloys VT5 (Ti-5Al) and VT5-1 (Ti-5Al-2Sn). Group I consists of low alloys of the martensitic type (OT4-type sheet titanium alloys), group II medium martensitic-type alloys (alloys VT6S, VT6, VT14, VT23), group III high martensitic-type alloys (alloy VT16), group IV low β alloys (alloys of the system Ti–12Mo–(4 to 6)Sn; Ti–12Mo–(4 to 6)Zr; Ti–11Mo–5Sn–5Zr), group V medium β-alloys (alloy VT15). Group VI consists of alloys containing 30 percent or more molybdenum. (JPRS)

782 UNUSUAL FRACTURE FEATURES OF OXIDIZED VANADIUM–1.31 AT. PERCENT TITANIUM ALLOY. **Hasson, Dennis F. (Univ. of Maryland, College Park); Arsenault, R. J.; Jellison, Jane. Contract AT(40-1)-3612. Mater. Sci. Eng.; 7: No. 4, 215-19(Apr 1971).**

Factography of a bcc solid solution vanadium +1.31 at. % titanium alloy has been examined by a scanning electron microscope (SEM). In this alloy titanium acts as a scavenger of interstitial impurities. Specimens in the annealed-"as received" condition and with oxygen concentrations of 0.083 and 1.14 at. % were fractured to observe the fracture morphology. The fracture morphology of the two specimens containing a large oxygen concentration had geometrically faceted fracture surfaces, and the presence of oxides was not found in the fracture features. Metallographic analysis showed the existence of oxide precipitates, and an explanation is advanced as to the differences in the SEM and metallographic results. (auth)

783 STRUCTURAL CHANGES DURING DEFORMATION OF MOLYBDENUM ALLOYS. **Kaverina, S. N.; Dizunov, V. A.; Minakov, V. N.; Trefilov, V. I. (Inst. of Metal Physics, Kiev). Metallofizika; No. 39, 57-65(1972). (In Russian).**

Molybdenum alloy samples containing primarily Ti, Nb, or Zr were examined after various regimens of thermomechanical treatment: high-temperature rolling with intervening warming and low-temperature rolling with intervening annealing. Structural change indications were obtained by optical and electron microscopic techniques by transillumination. Parameters of the crystalline lattice and mechanical properties of the alloys were obtained in the deformed state and after annealing at 1100 to 2000°C. Low-temperature rolling significantly lowered the temperature of transition from the plastic state to the brittle state, increasing the temperature of recrystallization. (tr-auth).

784 EFFECT OF SOME REFRACTORY OXIDES ON THE SUPERCOOLING AND STRUCTURE OF IRON. **Kostyuchenko, V. P.; Ovsienko, D. E. (Inst. of Metal Physics, Kiev). Metallofizika; No. 39, 96-102(1972). (In Russian).**

The influence of MgO, BeO, ZrO_2, Al_2O_3–TiO_2, and SiO_2 on the supercooling and the structure of Fe ingots is described. MgO removed the supercooling of Fe and reduced the size of the structure somewhat; BeO, ZrO_2, and Al_2O_3 decreased the supercooling to 140°C, and, with the exception of ZrO_2, decreased the grain size but had no effect on the macrostructure. TiO_2 and SiO_2 did not prevent the obtaining of the maximum supercooling of Fe (280°) and had no effect on the macrostructure. (tr-auth)

785 APPLICATIONS OF ELECTRON MICROFRACTOGRAPHY TO MATERIALS RESEARCH. **Symposium Held at Toronto, Ont., Canada, June 21–26, 1970. Philadelphia; American Society for Testing and Materials (1971). 101p. $8.25. (ASTM-STP-493; CONF-700673).**

Six papers were presented at the symposium. A separate abstract was prepared for each of three papers. Papers for which no abstracts were prepared are concerned with fracture of Al alloys, fracture of steel, and failure of honeycomb structures. (J.R.D.)

For abstracts of individual papers see: 786–788.

786 CORRELATION OF FRACTURE TOUGHNESS K_{Ic}, WITH FRACTOGRAPHICALLY DERIVED PLASTIC STRETCHED ZONE WIDTH: A REPORT OF ASTM E-24/II TASK GROUP. **Brothers, A. J. (General Electric Co., Schenectady, N. Y.); Hill, M.; Parker, M. T.; (and others). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. 493; 3-19(1971).**

From Symposium on applications of electron microfractography to materials research; Toronto, Ontario, Canada (21 Jun 1970).

The results of a Task Group effort of E-24 Subcommittee II on Fractography are described. The study was conducted to determine quantitative correlation between fracture toughness, K_{Ic}, and the fractographically derived width of the stretched zone preceding fracture in fracture toughness specimens. The correlation was obtained for two high-strength aluminum alloys, a 6Al-4V titanium alloy and a 18Ni maraging steel heat treated to a strength level range of 170,000 to 260,000 psi. It is observed that the width of the stretched zone increases with increasing fracture toughness and material ductility, and exhibits good correlation with the calculated crack opening displacement, that is, the nominal displacement of the crack surfaces normal to the plane of the crack. The width of the stretched zone shows no apparent dependence on, or correlation with, material grain size. Features of the 7075-T6 alloy, for which fractographic features were defined most clearly and documented most extensively, suggest that the stretched zone represents a region of local strain at the crack tip which forms on loading and prior to incipient cracking. The features of the transition from the stretched zone to the fracture region in this alloy suggest that fracture is induced primarily by achieving critical conditions beyond the crack tip, and is not simply associated with tearing at a critical crack tip strain level. (auth)

787 APPLICATION OF ELECTRON FRACTOGRAPHY TO THE STUDY OF HIGH-TEMPERATURE CAVITATION IN TUNGSTEN. **Farrell, K.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. 493; 71-9(1971).**

From Symposium on applications of electron microfractography to materials research; Toronto, Ontario, Canada (21 Jun 1970).

Because brittle fracture surfaces sometimes carry a clear imprint of the results of prior thermomechanical history of a material, electron fractography can be used to glean information on this history. This is particularly so for those high-temperature phenomena that involve the development of elimination of small holes in solids. Examples of such holes are sintering pores, creep cavities, and gas bubbles. If the matrix is brittle at low temperatures the holes can be exposed for detailed microscopic examination simply by snapping the specimen at low temperature. This requirement is satisfied in tungsten in which the crystallography and the growth rates of gas bubbles, the morphologies of creep cavities, and the mechanism of hot cracking in fusion welds were studied. (auth)

788 ELECTRON FRACTOGRAPHY OF HIGH TEMPERATURE, HIGH STRAIN RATE FRACTURE. **Wilber, G. A.; Bucher, J. H. (Jones and Laughlin Steel Corp., Pittsburgh). ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ. 493; 80-96(1971).**

From Symposium on applications of electron microfractography to materials research; Toronto, Ontario, Canada (21 Jun 1970).

It is shown that electron microfractography can be applied to the study of high temperature, high strain rate fracture. Although the fracture surfaces exhibited some oxidation and thermal etching, the quality of the fractographs was adequate to identify the operative fracture modes for a variety of alloys and test conditions. Three alloys were studied: (1) a nickel base superalloy (Inconel 718), (2) an austenitic stainless steel (AISI 304), and (3) a low carbon steel (AISI 1008). High strain rate, hot tension tests were carried out in vacuum or in argon after direct heating to the test temperature and after cooling from a reheating temperature typical of hot rolling operations. The hot ductility, as indicated by the reduction in area at fracture, is described in terms of various temperature-ductility ranges which cover incipient melting as well as normal hot working temperatures. Electron fractography was combined with metallographic observations to obtain a more detailed description of this hot ductility behavior. A variety of fracture modes were observed depending on the alloy and test conditions with examples of transgranular shear rupture, intergranular shear rupture, and brittle intergranular decohesion. Despite the

high deformation temperatures, some of the fracture surfaces exhibited areas of cleavage and brittle interphase separation resulting from crack initiation at second phase particles. A description of the specific fracture modes in each temperature-ductility range is given for each alloy, and the reasons for the observed variations in hot ductility are discussed. (auth)

789 REACTION OF INDIUM ANTIMONIDE WITH AuIn. **Babitsyna, A. A.; Luzhnaya, N. P. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 6, 1741-3(Jun 1972). (In Russian).**

The phase composition diagram was constructed for the binary system InSb–AuIn, using differential thermal analysis, microstructure analysis, microhardness and x-ray diffraction. Three phase regions were distinguished and based on the compounds InSb, $AuIn_2$, and AuIn. The possible existence of solid solutions is postulated. (tr-auth)

790 CHARACTER OF THE LAVES PHASES INTERACTION IN THE SYSTEMS $Zr(Fe, Co, Ni)_2$–ZrV_2. **Pet'kov, V. V.; Svechnikov, V. M. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 7, 664-7(Jul 1972). (In Ukrainian).**

By the methods of x-ray, differential thermal, and microstructural analyses the systems $Zr(Fe, Co, Ni)_2$–ZrV_2 were investigated. For the systems $ZrFe_2$–ZrV_2 and $ZrCo_2$–ZrV_2 variants of polythermal sections are suggested; for the system $ZrNi_2$–ZrV_2 phase equilibria were established at 900°C. All the systems were characterized by formation of the ternary Laves phases with the $MgZn_2$-type structure and by considerable regions of solid solutions on the base of both binary and ternary λ-phases. The results obtained were in agreement with the Dwight rule on formation of ternary compounds if binary phases belong to non-adjoining zones I $\lambda_2(ZrV_2)$ and II $\lambda_2(ZrFe_2, ZrCo_2, ZrNi_2)$. (auth)

791 COMPOUND In_2Bi. **Stel'makh, S. I.; Tsimmergakl, V. A.; Sheka, I. A. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 7, 631-3(Jul 1972). (In Russian).**

The In_2Bi–Sn section of the ternary system In–Bi–Sn was investigated by differential thermal analysis in a vacuum. Microscopic and x-ray analyses aided in establishing that the In_2Bi–Sn section is not quasi-binary, but that In_2Bi is an incongruently melting compound. The effect of a third component on the formation of the intermetallide was helpful in certain cases during the construction of the In_2Bi–Sn melting point diagram. (tr-auth)

792 ANALYSIS OF THE EMISSIVE PROPERTIES OF MOLYBDENUM FROM 1000 TO 2000 K. **Vujnovic, V.; Grzeta, B. (Univ., Zagreb). Fizika (Zagreb); 4: No. 3, 173-7(Jul 1972).**

Normal spectral radiance of molybdenum was evaluated according to published emissivity data. From the spectral radiance the reduced curve was obtained and the total radiance, total emissivity, maximum-spectral-radiance wavelength, and maximum-spectral radiance. An empirical formula was found for the wavelength of the maximum spectral radiance. (auth)

793 EFFECTS OF ALLOYING ELEMENTS ON ELEVATED-TEMPERATURE MECHANICAL STRENGTH OF HIGH Cr, Ni-BASE HEAT RESISTANT ALLOY. **Shimotori, Kazumi; Amano, Kagetaka; Fukasawa, Yoshiharu (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). J. Jap. Inst. Metals; 36: No. 8, 818-25 (Aug 1972). (In Japanese).**

From the viewpoint of excellent resistance to hot corrosion, high Cr, Ni-base alloys seem highly potential, but their strengths are not sufficient. In this experiment, 15 heats of systematically varied compositions were prepared from the base alloy (36.4% Cr, 1% Al, 1% Ti, 4% Mo, 5% Ta and the balance Ni). Tensile and stress-rupture tests were carried out at 800°C. Metallographic examinations of the ruptured specimens and hardness measurements were also made. From these data, the effects of Al, B, C, Co, Cr, Mo, Ta, and Ti on the properties of the high Cr, Ni-base alloy were evaluated. The results showed that additions of 1% Al and 1% Ti greatly increased the age hardenability and tensile strength, as in the case of Ni base superalloy. But the hardenability of this alloy was found to be due to the duplex precipitations of bcc α phase and ordered fcc γ′ phase. Almost no improvement in stress-rupture strength was made by alloying with Al and Ti, but the strength of the alloy was improved when alloying was made in combination with Ta and/or Mo. Fractographic examinations revealed that there were predominant grain boundary cracks in the weaker specimens. (auth)

794 EFFECT OF PRE-STRAIN ON THE YIELD BEHAVIOR OF VANADIUM. **Pink, Erwin; Arsenault, Richard J. (Univ. of Maryland, College Park). Contract AT(40-1)-3612. Z. Metallk.; 63: No. 9, 578-80(Sep 1972).**

The yield stress of bcc metals is generally defined as a "lower yield stress." If there is no well defined yield drop, as occurs in pre-strained samples, the choice of the yield point is arbitrary and the results for the temperature dependences are strongly influenced. An investigation was undertaken to determine an exact measure for the yield stress. If the "macro-yield stress" where the activation volume becomes independent of strain is chosen, the results are the same irrespective of whether a yield drop occurs or not. (auth)

795 THERMODYNAMIC FUNCTIONS OF LIQUID ZINC–TIN–CADMIUM–BISMUTH SOLUTIONS. **Ptak, Wladyslaw; Moser, Zbigniew; Wypartowicz, Jan. Arch. Hutn.; 16: No. 3, 229-52(1971). (In Polish).**

Changes in the chemical potential of Zn, the changes in free energy, entropy, and heat of formation for molar solutions of the Zn–Sn–Cd–Bi system were calculated. The Krupkowski formulas permit calculation of the activity coefficients of the components in a multicomponent system from the experimental data for binary systems. The thermodynamic functions were calculated from the experimentally determined coefficient for Zn–Sn, Zn–Cd, Zn–Bi, and Sn–Bi systems. The results are summarized for a range of Sn concentrations for two temperatures, 714 and 877°K. In order to verify the calculations, the chemical potential of Zn in a Zn–Sn–Cd–Bi solution was determined experimentally. The two sets of results showed reasonable agreement. (Metals Abstr.)

796 CHANGE IN THE DISLOCATION STRUCTURE AND MECHANICAL PROPERTIES OF A MOLYBDENUM SINGLE CRYSTAL DURING VACUUM ANNEALING. **Ermatov, S. E.; Turdybekov, I. T.; Orozbaev, R. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 72-4(Jul-Aug 1971). (In Russian).**

The microhardness of a single crystal of Mo was measured after a two-hour period of annealing in a vacuum at 500, 700, 900, 1,000, and 1,200°C. The microhardness proved to be a function of the temperature of annealing above 900°C. Metallographic studies showed a redistribution of dislocations occurred within the crystal. (tr-auth)

797 LOW-TEMPERATURE CAVITATION-EROSION OF METALS SUBJECTED TO HIGH STATIC PRESSURES. **Krot, Yu. O.; Gavranek, V. V.; Bol'shutkin, D. N.; P'yanov, A. G. Vestn. Khar'kov. Politekh. Inst.; No. 55, 23-7(1971). (In Russian).**

The metals included Al, Cu, Ni, Fe, Mo, and Sn. The development of low temperature erosion was affected by the ductility of the metal. Comparisons of cavitation resistance with hardness at 77 and 293°K showed no single dependence between these properties. Suggestions are made as to which type of metal should be used in components of various cryogenic mechanisms subject to cavitation effects. (Referativnyi Zh.)

798 RHENIUM ALLOYS WITH IRON GROUP METALS: ELECTRODEPOSITION AND PROPERTIES. **Greco, V. Peter. Plating; 59: No. 2, 115-25(Feb 1972).**

The electrodeposition of thick deposits of Re codeposited with the Fe groups metals (binary systems) from various electrolytes was investigated. The behavior of the alloys (15 to 45 wt% Re) after heat treatment at temperatures ranging from 315 to 980°C (600 to 1800°F) was studied and the microstructural and microhardness changes are presented. X-ray diffraction data of the Co–Re system before and after heat treatment are also discussed. The effects of inert submicron sized dispersoids of Al_2O_3 on the microstructure and properties of Co–Re alloy coatings are presented. The data compiled show that sound, thick (75 to 180 μm) and smooth deposits of Co–Re and Fe–Re alloys can be obtained which could be considered for industrial applications. The results from the Ni–Re system were less satisfactory. The Co–Re alloys exhibited a significant increase in microhardness after heat treatment at 315°C and maintained their hardness until they reached approximately 815°C. The microstructures of the alloys were laminar superimposed over the columnar structure. The data showing the increase in hardness and in the recrystallization of Co with alloying temperature additions of Re and Al_2O_3 dispersoids are given. (56 references) (Metals Abstr.)

799 EFFECTS OF ZIRCONIUM AND TIN ON THE DUCTILITY OF TITANIUM ALLOYS. **Atroshenko, A. P.; Bogoyavlenskii, K. N.; Ushkov, S. S. Tr. Leningrad. Politekh. Inst.; No. 322, 132-6(1971). (In Russian).**

Studies were made on the effects of alloying additions of Zr and Sn on the ductility of Ti. Ti–Zr alloys have good ductility

at all temperatures encountered during their forging. The addition of Sn to Ti lowers the ductility at 293°K and in the range 773 to 1123°K. The results were used to develop production processes for the forging of components in these alloys. (Referativnyi Zh.)

800 MICRO-SEGREGATION AND EUTECTIC CARBIDE PRECIPITATION IN IRON–CARBON–TUNGSTEN ALLOYS. Hoffmeister, H.; Schuermann, E. (Technische Univ., Claustal, Ger.). Arch. Eisenhuettenw.; 43: No. 6, 449-56(1972). (In German).

Investigations into the micro-segregation and precipitation of primary carbides of iron–carbon–tungsten alloys containing 0.5 to 2.2% C and 1.0 to 12.4% W as well as <0.35% Si, <0.55% Mn, <0.03% P and <0.04% S are described. Information regarding the crystal segregation of tungsten as dependent on the total content of carbon up to the attainment of carbide saturation of the mixed crystals is presented. The relationship between the amount of primary carbides and increasing total amounts of carbon at constant tungsten content is discussed. Determination of proportions of the two carbides M_6C and M_3C, and effects of homogenization on the elimination of micro-segregation and precipitation of carbides rich in tungsten are summarized. (GF)

801 STRUCTURE AND HARDNESS OF ELECTROLYTIC INDIUM–THALLIUM ALLOYS. Tsareva, A. V.; Kochegarov, V. M. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 3, 691-3 (Mar 1972).

Translated from Zh. Prikl. Khim.; 45: No. 3, 680-2(Mar 1972).

Results of x-ray structure analysis showed that indium–thallium alloys are indium-based solid solutions over a wide concentration range; this is consistent with the phase diagram. However, one alloy test specimen contains three phases simultaneously in the concentration range corresponding to 20 wt.% of thallium. Determination of microhardness of the alloys confirms the presence of solid solutions, as the dependence of microhardness on composition is represented by a curve with a maximum. (auth)

802 PROPERTY MEASUREMENTS AT HIGH TEMPERATURES: LEVITATION CALORIMETRY STUDIES OF LIQUID METALS. Bonnell, David William. Houston, Tex.; Rice Univ. (1972). 139p. University Microfilms Order No. 72-26,395.

Thesis.

The electromagnetic levitation method of heating has been utilized with isothermal drop calorimetry to determine enthalpy increments for liquid refractory metals at high temperatures. The design of levitation systems and block-type drop calorimeters is considered in detail from an experimental point of view. Radiation and conduction losses are treated, and working equations for determining such corrections for free-falling bodies are presented. It was found that for temperature ranges in excess of 500 degrees Celsius above the melting point of transition metals, that heat capacity is constant to experimental precision. Enthalpy functions are presented for copper, platinum, niobium, and zirconium, and a summary table presents C_p, ΔH(fusion), ΔS(fusion), and T(fusion) given for ten transition elements studied by levitation calorimetry. The following equations represent the enthalpy increment functions measured. Copper: $H_T - H_{298} = 34.6\ (\pm 1.6) \times (T-1358) + 43119\ (\pm 577)$ j/mole (1387 < TK < 1889). Platinum: $H_T - H_{298} = 39.0\ (\pm 2.0) \times (T-2045) + 75988\ (\pm 775)$ j/mole (2202 < TK < 2631). Niobium: $H_T - H_{298} = 40.6\ (\pm 1.0) \times (T-2750) + 108227\ (\pm 240)$ j/mole (2738 < TK < 3292). Zirconium: $H_T - H_{298} = 40.7\ (\pm 0.7) \times (T-2128) + 75069 \pm 320$ j/mole (2233 < TK < 2839). A short description of the determination of the crystal system associated with a new higher temperature solid phase of GeF_2 is presented and the program utilizing Ito's method of powder x-ray pattern indexing is described. A preliminary investigation of the simultaneous application of two frequencies for levitation and the experimental problems encountered is presented. (Diss. Abstr. Int., B)

803 FRACTURE BEHAVIOR OF REACTOR PRESSURE VESSEL STEEL IN THE FRANGIBLE, TRANSITIONAL, AND TOUGH REGIMES. Witt, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.; 20: No. 1, 237-49(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903–(Vol.20,No.1).

One of the primary objectives of the USAEC's Heavy Section Steel Technology (HSST) program is to develop a technology for assessing the margins of safety against failure of the large heavy section pressure vessels typical of the commercial boiling water and pressurized water reactor power plants. The several test programs which have been carried out on large specimens up to 12-in thick are reviewed and how the results from such tests relate to the establishment of quantitative methods for making calculations with a practical degree of accuracy for fracture throughout the entire gamut of behaviors from frangible and transitional (mixed-mode) to tough fractures is summarized. Extensive test results have been obtained on dynamic tear specimens in thicknesses up to 12 in and at temperatures resulting in frangible through tough behaviors (that is, from considerably below room temperature up to 550°F). Large flawed 6-in thick tensile specimens have also been tested from below room temperature to over 200°F. Several series of small flawed pressure vessels have been tested and a series is scheduled for early 1972 which features vessels up to 6-in thick. Linear elastic fracture mechanics as well as elastic-plastic methods of analyzing for other frangible behavior are reviewed and the data obtained to date are interpreted on the basis of these methods. The methods included are: the transition temperature approach; the gross strain approach; the crack opening displacement approach; and the equivalent energy approach. Special attention will be devoted to the equivalent energy approach since it has been used quite successfully in predicting and interpreting the fracture behavior of the thick-section tests performed under the HSST program. (auth)

804 HEAT TREATMENT OF VANADIUM AND THE RECRYSTALLIZATION DIAGRAM. Izotov, V. M.; Mel'nikova, L. V.; Evseeva, I. A.; Shuvilina, I. N. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov, No. 10, 163-8(1970). (In Russian).

A study was made on the heat treatment of aluminothermic and electrolytic V produced by ac and electron-beam melting. The mechanical properties depend on the degree of deformation and the annealing temperature. Metallographic and x-ray methods were used to determine the temperature for the onset of recrystallization of V prepared by the different methods. The temperature for the abrupt recovery of V agrees with this temperature. A recrystallization diagram for aluminothermic V was constructed to obtain a complete characterization of the heat treatment process. (Referativnyi Zh.)

805 CREEP AND CREEP STRENGTH OF TUNGSTEN [ALLOY] WIRES. Karpinos, D. M. Probl. Prochnosti; No. 1, 70-3 (Jan 1972). (In Russian).

The creep characteristics of several types of W alloy wire were studied by analyzing the results of creep tests conducted over periods of up to 100 h at 900 to 1200°C. Up to 1100°C the strongest wire in this respect was one containing Re 20%. Above this temperature the strongest was the alloy containing ThO_2 1.5%. The long-term (creep) strength of these materials at high temperature fitted either a power or an exponential curve, depending on the degree of approximation required. The theoretical implications of this type of fitting were also considered. (Metals Abstr.)

806 EFFECT OF THE CONDITIONS ON HIGH-TEMPERATURE ROLLING ON THE PHYSICO-MECHANICAL PROPERTIES OF REFRACTORY METALS. Gurevich, Ya. B.; Orzhekhovskii, V. L. Tr. Nauch. Issled. Proekt. Inst. Splavov Obrabot. Tzvet. Met.; No. 34, 109-18(1971). (In Russian).

A study was made on the effects of impurity content and the properties of Ti, Mo, Nb, and W on the rolling conditions and particularly on the temperature/deformation factors and treatment atmosphere, i.e., vacuum, inert gas, or the usual air. It is preferable that the high temperature treatment of the easily oxidized metals and alloys should take place in an atmosphere of inert gases or in a vacuum. (Referativnyi Zh.)

807 COMPARATIVE STUDY OF THE STRUCTURE OF HOT-WORKED AND HYDRAULIC-EXTRUDED MOLYBDENUM ALLOY, VM1. Mal'tsev, M. V.; Chudarev, L. F.; Biryukova, T. A.; Lantsova, L. P. Sb. Tr. Vses. Nauch.-Issled. Proekt. Inst. Tugoplavk. Met. Tverd. Splavov; No. 10, 135-8(1970). (In Russian).

The structure of the Mo alloy VMI was compared in the hot-forged and extruded conditions. The extruded alloy had greater hardness and working was more uniform compared with the forged alloy. In the recrystallized state, extruded chips, turnings, etc., of this alloy gave a more uniform and fine-grained structure than the forged alloy. (Referativnyi Zh.)

808 COMPARISON OF THE EFFECT OF INWARD AND OUTWARD DIFFUSION ALUMINIDE COATINGS ON THE FATIGUE BEHAVIOR OF NICKEL-BASE SUPERALLOYS. Andersen, P. J.; Boone, D. H.; Paskiet, G. F. (Pratt and Whitney Aircraft, East Hartford, Conn.). Oxidation Metals; 4: No. 2, 113-19(Jun 1972).

Results are presented which show that there is a basic difference between the failure modes of inward and outward diffusion aluminide coatings in elevated temperature fatigue of these alloys. The cause of the different failure mode of the outward coating appears to be that at elevated temperatures the coarse columnar grain β (NiAl) outer coating zone has reduced grain boundary strength and ductility. It was found that the coarse-grained stoichiometric NiAl has lower strength and ductility than

a finer grain NiAl which was produced by adding small amounts of molybdenum. It appears that a similar situation may exist in the case of aluminide coatings on nickel base superalloys with the fine grain size being at least initially stabilized in inward coatings by substrate elements, such as molybdenum, which precipitate in the NiAl coating. (J.R.D.)

809 SOLUBILITY OF CARBON IN RHODIUM, RUTHENIUM, IRIDIUM, AND RHENIUM. Arnoult, William J.; McLellan, Rex B. (William Marsh Rice Univ., Houston, Tex.). Scr. Met.; 6: No. 10, 1013-18(Oct 1972).

Results of vapor transport investigations of the solid solubility of C in Rh at 820 to 1256°C, Ru at 825 to 1256°C, Ir at 820 to 1256°C, and Re at 820 to 1256°C are reported. Results are presented tabularly and graphically. (J.R.D.)

810 ANOMALOUS SPECIFIC HEAT AND DISORDER OF THE METALS INDIUM, TIN, LEAD, ZINC, ANTIMONY, AND ALUMINUM. Kramer, W.; Noelting, J. (Univ., Goettingen, Ger.). Acta Met.; 20: No. 12, 1353-9(Dec 1972). (In German).

The specific heats of the metals indium, tin, lead, zinc, antimony, and aluminum were determined up to the melting points. Disorder data can be deduced from c_p values anomalously increasing near the melting points. Discrepancies between the values for aluminum and values found by other methods can be eliminated by evaluating specific heats at constant volume (c_v) instead of specific heats at constant pressure (c_p). Unfortunately, the macroscopic data necessary for this procedure are only known for aluminum with sufficient accuracy; thus the proposed evaluation method is so far applicable only to this case. (auth)

811 PROPERTIES OF ZIRCALOY CLADDING. Pickman, D. O. (United Kingdom Atomic Energy Authority, Preston, Eng.). Nucl. Eng. Des.; 21: No. 2, 212-36(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

The mechanical aspects of fuel cladding, especially the Zircaloy's and their relation to performance requirements under BWR and PWR conditions, which, in this area, are not greatly dissimilar are discussed. (24 references). (auth)

812 COMPARISON OF PELLET AND VIPAC NUCLEAR FUELS. Freshley, M. D. (Battelle-Northwest, Richland, Wash.). Contract AT-(45-1)-1830. Nucl. Eng. Des.; 21: No. 2, 264-78 (1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

Cold-press-sinter pellet fuels, under development since 1954, are widely used in commercial thermal power reactors and are generally accepted as being the standard fuel type. This widespread use has resulted in the development of considerable technology related to this fuel type, and the system is reasonably well understood. If proper attention is devoted to design and fabrication, pellet fuel performs satisfactory and meets the performance requirements imposed by present operating conditions. Vibrationally compacted ceramic fuel is considered to be the most promising alternate fuel form. Although of interest since 1959, the effort devoted to the development of vipac fuel has been considerably less than for pellet fuel. Consequently, vipac fuel is not generally accepted for commercial application at the present time. However, the concept is of continuing interest because it possesses several potential advantages over pellet type fuel. (auth)

813 CALCULATION OF THE MISCIBILITY GAP CURVE OF U–Mo γ-SOLID SOLUTION. Ivanov, O. S.; Udovskii, A. L. Vamberskii, Yu. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 203: No. 5, 1107-10(11 Apr 1972). (In Russian).

Stratification curves for solid solutions in the system uranium-molybdenum were calculated with the aid of a computer over the temperature range 900 to 1,400°K without the use of experimental points from phase composition diagrams. Coefficients of thermal expansion, entropy and other thermodynamic data were utilized in constructing curves showing the dependence of free energy on concentration, and in miscibility gap investigation. Good agreement of calculated curves with experimental curves was obtained. (K.S.W.)

814 CREEP DURING THE HOT PRESSING OF REFRACTORY METALS WITH ADDITION OF OXIDES. Samsonov, G. V.; Kovalchenko, M. S.; Fen, E. K.; (and others) (Inst. for Materials Development, Kiev). Phys. Sintering; 4: No. 3, 141-9(Sep 1972).

Creep processes in niobium, molybdenum, and tungsten powders with and without oxides additions during hot pressing were analyzed. Dependence of the creep rate on temperature and pressure applied, as well as positive effect of oxides additions on it were confirmed. By determination of Laplasse's pressure, activation energy was represented as a sum of vacancy movement energy and energy of steps. (auth)

815 EUTECTIC MORPHOLOGY IN THE Cd–Pb–Sn SYSTEM. Bao, Ha-Quac; Durand, F. C. L. (Laboratoire de Thermodynamique et Physico-Chimie Metallurgiques, Saint-Martin-d'Heres, France). J. Cryst. Growth; 15: No. 4, 291-5(Sep 1972). (In French).

As the composition of the alloy varies along the monovariant line between the two-phase Cd–Sn eutectic and the three-phase Cd–Sn–Pb eutectic, the evolution of the unidirectional solidification microstructure can be described in five stages: (a) lamellar Cd–Sn eutectic; (b) eutectic cells; (c) plates separated by three-phase Cd–Sn–Pb walls; (d) binary eutectic dendrites; (e) three-phase Cd–Sn–Pb eutectic. For the three-phase eutectic, the interlamellar spacing λ obeys the usual law: $\lambda^2 V$ = constant = 16×10^{-12} cm^3 s^{-1}. (auth)

816 ADSORPTION–DESORPTION PHENOMENA. Proceedings of the II International Conference Held at Florence, Italy, April 14–17, 1971. Ricca, F. (ed.). London; Academic Press (1972). 463p. £ 6.50. (CONF-710459).

Thirty-two papers were presented under the following Section titles: (1) Theoretical studies on physical adsorption, (2) particle beams in gas–solid interaction studies, and (3) chemisorption of gases by metals. Separate abstracts have been prepared for five of these papers. (UK)

For abstracts of individual sections see: 817–819, 1196, and 1896.

817 SURFACE LIFETIMES OF THE ALKALIES AND HALOGENS ON MOLYBDENUM. Scheer, M. D.; Klein, R.; McKinley, J. D. (National Bureau of Standards, Washington, D. C.). pp 169-88 of Adsorption–Desorption Phenomena. /Ricca, F. (ed.). London; Academic Press (1972).

From second international conference on adsorption–desorption phenomena; Florence, Italy (14 Apr 1971). See CONF-710459.

It is stated that the measurement of halogen surface lifetimes on metal surfaces has not previously been reported. In the experimental work described, a modulated beam of CsI was used to produce a dilute adlayer on a Mo surface. At temperatures above 1350°K, such a layer was almost completely dissociated and under these conditions halogen surface lifetimes were in the millisecond range, while the Cs adatom lifetime was in the microsecond range; hence within a millisecond after the beam shutter closed, the surface layer consisted almost entirely of the halogen, which desorbed as neutrals and negative ions. The desorption of alkali and halogen atoms from a metal surface takes place as two parallel processes; in one process a positive alkali or negative halogen ion is emitted, while in the other a neutral atom desorbs into the gas phase. At a given surface temperature, the ratio of the rates of these two processes is determined by the metal affinity for the valence electron and the ionization potentials of the alkali atom and negative halogen ion. A review is also given of earlier work on the interaction of alkali metal atoms with metal surfaces. Among matters discussed are the work function of Mo, the kinetics of desorption, adlayer mobility, the Arrhenius pre-exponential factor, and surface ionization potentials. (25 references) (UK)

818 INTERACTION OF IONS AND ELECTRONS WITH ABSORBED GASES. Clampitt, R. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). pp 203-12 of Adsorption–Desorption Phenomena. /Ricca, F. (ed.). London; Academic Press (1972).

From second international conference on adsorption–desorption phenomena; Florence, Italy (14 Apr 1971). See CONF-710459.

It is stated that collisions between electrons or ions with atoms or molecules weakly bound to a surface are often similar to those occurring in the gas phase. Electrons may excite the adsorbed species to radiative, forbidden, or ionizing states, giving, respectively, radiation, excited particles, or ions. Ions may undergo elastic or inelastic scattering, be neutralized by charge exchange to a radiative or forbidden state, undergo an ion–molecule reaction, or may simply induce a dipole in an otherwise nonreactive adsorbed atom. With the apparatus described, the surface being studied can be bombarded with beams of electrons or mass-selected ions, and ejected and reflected ions analyzed with a mass spectrometer located 1 cm away. Excited neutral species pass along a 50-cm flight tube and are detected by electron ejection at a particle multiplier. A quench field and uv photomultiplier are located along the flight tube. The target can be cooled to 3°K or heated thermally. Some results for Cu and Mo/adsorbed gas systems are discussed. (11 references) (UK)

819 IDENTIFICATION OF THE CHEMICAL STATE OF ADSORBED SPECIES WITH AUGER-ELECTRON SPECTROSCOPY. Haas, T. W.; Grant, J. T.; Dooley, G. J. (Wright-Patterson AFB, Ohio). pp 359-68 of Adsorption-Desorption Phenomena. /Ricca, F. (ed.). London; Academic Press (1972).

From second international conference on adsorption-desorption phenomena; Florence, Italy (14 Apr 1971). See CONF-710459.

Results are reported that illustrate how Auger electron spectroscopy can be useful in determining the chemical state of adsorbed species and hence the chemical bonds formed between adsorbate-adsorbent atoms during the adsorption process. Two main effects looked for in Auger spectra are those that are useful in defining the chemical state of an adsorbed atom. The first is a shift in the energy of an Auger electron; this effect is observed when charge transfer occurs. If electrons are transferred from a less to a more electronegative element, the binding energies of the remaining electrons in the positively charged atom are increased and the energies at which the Auger electrons will appear are decreased; the greater the amount of charge transfer (change of valence state) the greater the shift. Unfortunately, however, crystal field effects are involved and energy shift cannot simply be equated with charge transfer. The second important chemical effect in Auger spectroscopy obtains when the electrons involved in the Auger process include the valence electrons. In this case a change in the type of chemical bonding requires a change in the wave function used to describe valence electrons and this in turn means a different transition probability for a given Auger process. This leads to a change in the shape of a complex Auger spectrum, giving a clue for the species involved that can be useful in identifying the chemical state of certain surface atoms. Experimental studies in this field are described for CO adsorption on W, Mo, Nb, and Ta and for the Auger spectrum of C. (17 references) (UK)

820 X-RAY AND NEUTRON DETERMINATION OF A SO-CALLED Th_2Ni_{17}-TYPE STRUCTURE IN THE LUTETIUM-IRON SYSTEM. Givord, D. (CNRS, Grenoble, France); Lemaire, R.; Moreau, J. M.; Roudaut, E. J. Less-Common Metals; 29: 361-9 (1972).

The iron-rich lutetium compound crystallizes in a hexagonal structure, space group $P6_3/mmc$. By x-ray and neutron diffraction single crystal studies it was shown that its structure does not belong to the ideal Th_2Ni_{17}-type as previously proposed. The structure under investigation is established by ordered substitutions occurring in the $CaCu_5$ subcells on two of the three chains of lutetium atoms, parallel to the $\vec{c}$-axis. These substitutions lead to an increase of the c parameter which allows for some disordered substitutions on the third chain and the stoichiometry shifts from $LuFe_{8.5}$ to $LuFe_{9.5}$. (auth)

821 ALLOY HARDENING AND SOFTENING IN BINARY MOLYBDENUM ALLOYS AS RELATED TO ELECTRON CONCENTRATION. Stephens, Joseph R.; Witzke, Walter R. (Lewis Research Center, Cleveland, Ohio). J. Less-Common Metals; 29: 371-88(1972).

An investigation was conducted to determine the effects of alloy additions of Hf, Ta, W, Re, Os, Ir, and Pt on the hardness of Mo. Special emphasis was placed on alloy softening in these binary Mo alloys. A modified micro-hardness test unit permitted hardness determinations at homologous temperatures ranging from 0.02 to 0.15, where alloy softening normally occurs in bcc alloys. Results showed that alloy softening was produced by those elements having an excess of s + d electrons compared to Mo while those elements having an equal number or fewer s + d electrons than Mo failed to produce alloy softening. The magnitude of the softening and the amount of solute element at the hardness minimum diminished rapidly with increasing test temperature. At solute concentrations where alloy softening was observed, the temperature sensitivity of hardness was lowered. For solute elements having an excess of s + d electrons or fewer s + d electrons than Mo, alloy softening and alloy hardening can be correlated with the difference in number of s + d electrons of the solute element and Mo. (auth)

822 EVIDENCE OF DISORDERED SUBSTITUTIONS IN THE Th_2Ni_{17}-TYPE STRUCTURE EXACT STRUCTURE DETERMINATION OF THE Th-Ni, Y-Ni, AND Er-Co COMPOUNDS. Givord, D. (CNRS, Grenoble, France); Givord, F.; Lemaire, R.; James, W. J.; Shah, J. S. J. Less-Common Metals; 29: 389-96(1972).

Hexagonal intermetallic compounds close to R_2M_{17} stoichiometry in the Th-Ni, Y-Ni and Er-Co systems have been studied by single crystal x-ray techniques. All of these compounds have been previously reported as belonging to the Th_2Ni_{17}-type structure. In fact, this structure type does not exist but is an ideal case. The nature of the observed extinctions and refinement of the crystal structures show that substitutions must occur on all R rows parallel to the $\vec{c}$-axis with the subsequent displacements of the M atoms. This leads to a non-stoichiometric composition, e.g., $ThNi_{9.5}$. (auth)

823 SOLID STATE ELECTROCHEMICAL DETERMINATION OF THE THERMODYNAMIC STABILITY OF THE Co_3Nb PHASE. Barbi, G. B. (EURATOM-CCR, Ispra, Italy); Monti, P. J. Less-Common Metals; 29: 397-406(1972).

Electromotive force measurements across the all solid galvanic cells: $Pt|Fe + "FeO"|ThO_2 + LaO_{1.5}|Co + Co_3Nb + NbO_2|Pt$ and $Pt|Fe + "FeO"|ThO_2 + YO_{1.5}|Co + Co_3Nb + NbO_2|Pt$ were carried out after constant current cathodic polarization. The emf vs time decay curves are interpreted in terms of the non-stationary presence of certain thermodynamic systems at the interface between the working electrode and the intermediate solid electrolyte. It is then possible to evaluate the oxygen chemical potential in equilibrium with the system $Co + Co_3Nb + NbO_2$ from the corresponding, well defined, rest potential value. Assuming as a first order approximation the cobalt phase to be a pure phase, the standard free energy of formation of Co_3NB, between 1000 and 1400°K is given by the expression: $\Delta G^0_{f,Co_3Nb} = -19.28 + 0.00293 \cdot T$ kcal/mole. (auth)

824 FORMATION OF THE INTERMEDIATE PHASES OF THE SYSTEM THORIUM-COPPER IN LIQUID SODIUM. Berlin, Bo (Aktiebolaget Atomenergi, Studsvik, Sweden). J. Less-Common Metals; 29: 337-48(1972).

The formation in liquid sodium of the intermediate phases of the system Th-Cu has been studied in the temperature range 200 to 700°C. The reaction products are obtained in a finely-divided and well-crystallized condition at temperatures appreciably below the melting points. It appears that sodium does not participate in the formation process as a catalyst, but nevertheless promotes the reactions by activating the copper surfaces. The phases formed in liquid sodium were generally less pyrophoric than those obtained by vacuum melting. The cell dimensions of the previously reported phases Th_2Cu and $ThCu_7$ have now been refined by x-ray diffraction. The existence of the predicted phases $ThCu_3$ and $ThCu_6$ has been confirmed. $ThCu_3$ was found to be a hexagonal phase, space group $P6_3$ or $P6_3/m$, the unit cell dimensions being $a_0 = 11.8262 \pm 6$ Å, $c_0 = 8.8223 \pm 6$ Å. $ThCu_6$ has the orthorhombic crystal structure, space group Pnma, the unit cell dimensions being $a_0 = 8.1063 \pm 4$ Å, $b_0 = 10.1193 \pm 6$ Å, $c_0 = 5.0672 \pm 3$ Å. (auth)

825 CONTRIBUTION TO THE PHASE DIAGRAM OF Pd-In-Sn AND SEVERAL RELATED MIXTURES. Kosovinc, I. (Univ., Ljubljana, Yugoslavia); El-Boragy, M.; Schubert, K. Metall; 26: No. 9, 917-20(Sep 1972). (In German).

Structural variations in the $PdSn_2$ structure were studied in several mixtures. Replacement of Sn through In had no significant effect. Conversely, replacement of Sn through In had no significant effect. The replacement of Pd with other atoms led to a new system. (tr-auth)

826 SYSTEM In-Sn-InBi. Stel'makh, S. I.; Tsimmergakl, V. A.; Sheka, I. A. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 9, 855-9(Sep 1972). (In Russian).

Alloys of the quasi-ternary system In-Sn-InBi were investigated by differential thermal analysis. The phase diagram was constructed on polythermal sections using the method of D. A. Petrov (1941), which was found useful in the construction of phase diagrams of quite complex systems. A ternary diagram was also established for the system In-Sn-Bi. (K.S.W.)

827 EFFECT OF MOLYBDENUM ON THE HIGH-TEMPERATURE CREEP OF NIOBIUM. Lazarev, E. M.; Ugaste, Yu. E. Probl. Prochnosti; No. 3, 54-6(Mar 1972). (In Russian).

The high-temperature creep of Nb-Mo alloys of various compositions was studied by measuring the hot hardness and applying tensile and torsion tests at 1100 to 1500°C in vacuum (10^{-5} torr). The activation energy of high-temperature creep correlated exactly with the activation energy of normal diffusion in the Nb-Mo system. The creep velocity of the alloys studied constituted a power function of the applied stress. Over the whole range considered alloying Nb with Mo increased the creep resistance of the resultant solid solutions. (Metals Abstr.)

828 DISTRIBUTION OF DISLOCATIONS IN DEFORMED bcc METALS. Ikeda, S. (National Research Inst. for Metals, Tokyo). Nippon Kinzoku Gakkai Kaiho; 11: No. 2, 97-104 (Feb 1972). (In Japanese).

The disposition of dislocations in deformed single crystals of bcc metals such as Fe, Vb-group, and VIb group metals was found by means of an electron microscope. The observed disposition was classified as follows: uniformly distributed screw dislocations; in addition to the screw dislocations, clusters of dislocation dipoles

or massive tangles of dislocations were found; plate-like tangles along slip planes with the screw dislocations between them; cellular structure with boundaries along the slip planes; and networks of the dislocations with nodes. Generally, an increase in strain or rise in the temperature of deformation tended to change the disposition from the first to the last classification. The reason is discussed qualitatively. Some theories relating mean density of the dislocations with work hardening are briefly explained. (Japan)

829 LOW-CYCLE FATIGUE OF REACTOR STRUCTURAL MATERIALS. Jaske, C. E.; Perrin, J. S.; Mindlin, H. (Battelle Memorial Inst., Columbus, Ohio). Reactor Technol.; 15: No. 3, 185-207(1972).

Low-cycle fatigue and creep–fatigue are important considerations in evaluation and development of design information for reactor structural materials. Strain-controlled low-cycle fatigue tests of axially loaded specimens of Alloy 800, 304 stainless steel, and 316 stainless steel have been conducted at several laboratories. Fatigue curves for these three alloys have been developed at temperatures from 70 to 1500°F. Hold times at peak strain and slower strain rates have been shown to greatly reduce cyclic-fatigue resistance at temperatures between 1000 and 1400°F. The linear-life-fraction damage rule has been used to evaluate creep–fatigue damage interaction in tension hold-time tests, but it does not provide a proper explanation of the damage mechanisms. These materials exhibited significant cyclic strain hardening at all temperatures studied. The hardening mechanism was influenced by strain rate, number of strain cycles, and prior heat treatment of the alloy. Aging of material at test temperature prior to test had a significant influence on both creep–fatigue resistance and cyclic hardening at temperatures near 1100 to 1200°F but had little effect at temperatures near 1000 to 1050°F. (auth)

830 PHYSICAL PROPERTIES OF VANADIUM. Neimark, B. E.; Belyakova, P. E.; Brodskii, B. R.; (and others). pp 63-7 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

An investigation of the physical properties of vanadium was made, including thermal expansion, thermal conductivity, specific electric resistance, Lorentz numbers over the temperature interval 20 to 1,400°C, integral and monochromatic coefficient of emission between 900 and 1,400°C, the heat capacity, modulus of elasticity, and internal friction between 20 and 1,000°C. (tr-auth)

831 PHYSICAL PROPERTIES OF HOT-PRESSED PSEUDO-ALLOYS OF TUNGSTEN–COPPER. Karpinos, D. M.; Kondrat'ev, Yu. V.; Klimenko, V. S.; (and others). pp 75-7 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

The electric and thermal conductivities of hot-pressed pseudo-alloys of W–8 to 9% Cu were measured in the temperature range 300 to 2200°K. The thermal conductivity to 1300°K was measured in a vacuum by Kohlrauch's method; above 1300°K the stationary method of radial heat flow was used. Both thermal and electric conductivities of the pseudoalloy exceed those of pure tungsten. (tr-auth)

832 EXPERIMENTAL STUDY OF THE INTEGRAL HEMISPHERICAL DEGREE OF BLACKNESS OF REFRACTORY METALS AND ALLOYS. Peletskii, V. E.; Druzhinin, V. P. pp 143-6 of Teplofizicheskie Svoistva Tverdykh Veshchestv. /Samsonov, G. V. (ed.). Moscow; Izdatel'stvo Nauka (1971). (In Russian).

From Thermophysical properties of solids meeting; Moscow, USSR (Oct 1968). See CONF-681091.

The characteristic features of experimental devices developed for the precision study of the integral hemispherical degree of blackness and specific energy resistance of single crystal and polycrystalline samples of refractory metals and alloys are described. The error of measurement did not exceed ±5 to 6% for the degree of blackness and ±1.0 to 1.5% for the specific energy resistance. Poly- and single-crystals of molybdenum, alloy of molybdenum with rhenium, pure rhenium, alloys of nickel with rhenium, and other materials were investigated. (auth) (JPRS)

833 MORPHOLOGY OF THE EUTECTIC IN Fe–W–C ALLOYS. Taran, Yu. N.; Ivanov, L. I.; Moshkevich, L. D. (Ukrainian Scientific-Research Inst. of Special Steel, Kiev). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 3-6(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 2-6 (Jan 1972).

Studies were made on the eutectic A + $(W,Fe)_6C$ in high-speed steels, such as R18 type (F–W–C alloys). In these steels the eutectic transformation L → A + $(W,Fe)_6C$ is the final step in solidification, and the form of the eutectic colonies and, in part, their internal structure are masked by the previously formed austenite. The results showed that in cast high-speed steel of the R18 type the eutectic sections are cross sections of eutectic dendrites, although the large volume of structurally free crystals of the primary solid solution and the presence of local temperature and concentration gradients greatly distort the regular shape of the dendrites and induce imperfections in the internal structure. (P.C.H.)

834 BRITTLE FRACTURE OF METALS. Morgunova, N. N. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 9-11(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 9-11 (Jan 1972).

General conclusions on the nature of brittle fracture of metals are summarized on the basis of data in the literature. Some of the metals discussed include Cr, Mo, and W. If it is assumed that the susceptibility of metals to brittle fracture is associated with the presence, aside from metallic bonds, of directed covalent bonds, then everything that favors the relative force of the directed bonds increases the susceptibility of the metal to brittle fracture. In the first stage of brittle fracture, during propagation of the crack, the major factor is the possibility of relaxing local elastic stresses, dependent on the dislocation mobility (taking into account the geometry of dislocation movements, interactions with interstitial impurities, etc.). In the second stage-brittle fracture proper- the main factor is the strength of the interatomic bonds. The stronger the interatomic bonds, the higher the concentration of local stresses in the tip of the crack must be in order to achieve complete fracture. (P.C.H.)

835 NATURE OF COLD BRITTLENESS IN REFRACTORY METALS OF GROUP VIa. Gavriliyuk, M. I. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 12-16(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 12-17 (Jan 1972).

The cold brittleness of W, Mo, and Cr is discussed in relation to physical properties and the presence of interstitial impurities. (P.C.H.)

836 EFFECT OF CARBON ON THE BRITTLENESS OF MOLYBDENUM–RHENIUM ALLOYS. Savitskii, E. M.; Konieva, L. Z.; Tylkina, M. A.; Morgunova, N. N. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 17-21(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 17-21(Jan 1972).

The effects of C on the ductile-to-brittle transition temperature, structure, and hardness of Mo and Mo + 47% Re were investigated. The results showed that the ductile-to-brittle transition temperature of Mo + 47% Re was considerably lower than that of molybdenum with the same carbon content. With 0.11% C the transition temperature of Mo + 47% was −196 to −60°C, while that of molybdenum was −20 to +80°C. The alloy of Mo + 47% Re + 0.13 C was ductile at room temperature, and a strip 0.5 mm thick was produced from it. The high ductility of Mo + 47% Re as compared with pure molybdenum (the so-called "rhenium effect") was due to the higher solubility of carbon in molybdenum alloyed with rhenium. (The solubility of carbon was five times higher in this alloy.) This led to a smaller amount and smaller size of carbide particles. Additions of rhenium also had a favorable effect on the composition of the carbides, their shape and distribution, and also exerted a modifying influence. (auth)

837 EFFECT OF PURITY ON THE STRUCTURE AND PROPERTIES OF MOLYBDENUM. Zelenskii, G. K.; Borodich, V. D.; Korontsevich, V. K. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 22-5(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 21-4 (Jan 1972).

Studies were made on the effects of purity on the structure and properties of Mo vacuum melted in arc or zone-melting furnaces. The results showed that with reduction of the melting rate in a vacuum arc furnace from 99 to 6 kg/h (hearth 100 mm in diameter) and an increase in the number of passes in zone refining from two to five (speed of refining 4 mm/min) the oxygen concentration in molybdenum decreased from 29×10^{-3} to 1×10^{-3} wt % and from 1×10^{-3} to 0.6×10^{-3} wt %, respectively. At the same time, the molybdenum was also notably freer of other impurities. The ductile and strength characteristics of molybdenum in the deformed condition and also the strength characteristics in the recrystallized condition were independent of the oxygen concentration within

limits of 0.001 to 0.029%; the ductile characteristics of recrystallized molybdenum improved with increasing purity and reached values of δ = 29% and ψ = 36% at 20°C in the purest molybdenum (0.001% O_2). The precipitates of second phase in the cast and recrystallized molybdenum of a compound of molybdenum and oxygen was distributed as separate inclusions primarily in the grain boundaries. An increase in the purity of molybdenum reduced the number and changed the shape of the inclusions in the grain boundaries. (auth)

838 INCREASING THE DUCTILITY OF CAST NIOBIUM ALLOYS BY HEAT TREATMENT. Filip'eva, O. A.; Volin, E. M.; Baeva, G. S.; Volina, N. Ya.; Lokshina, A. E. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 26-31(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 1, 24-30(Jan 1972).

Studies showed that supersaturated solid solutions comprising the major part of the cast metal in alloys VN3 (4.7 to 5.2% Mo, to 3 to 1.6% Zr, 0.1 to 0.16% C) and (9 to 10.2% Mo, 1.5% Zr, 0.25 to 0.3% C and 0.01% Ce) N4 tended to decompose at 1000 to 1500°C. Heat treatment conditions were established for alloys VN3 (1400°C for 3 to 5 h) and VN4 (1500°C for 3h + 1300°C for 10 h) ensuring overaging of the cast metal and a substantial increase of the ductility and workability. (auth)

839 MECHANICAL PROPERTIES OF TITANIUM ALLOYS WITH VANADIUM AND NIOBIUM AT LOW TEMPERATURES. Koshelev, P. F.; Mikheev, V. S.; Nikitin, P. N. (Inst. of Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR (Engl. Transl.); 14: No. 1-2, 111-13(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 2, 16-20(Feb 1972).

The mechanical properties at low temperatures from 20 to −269°C of binary Ti alloys with different contents of V and Nb were investigated. In addition to the standard mechanical properties, the sensitivity of the alloys to stress concentrators was also determined. Alloys with 3 to 11% Nb and 2 to 12% V and pure Ti were investigated. The results showed that with a drop in the test temperature to −253°C the strength of titanium alloys with up to 12% vanadium increased by 4.7 times but the alloy became brittle. In titanium alloys with 11% Nb with a drop in test temperature to −269°C the strength increased approximately 3.5 times and some ductility was maintained. In operation at low temperatures down to −196°C it is recommended that titanium alloys be used with up to 6 to 7% Nb, while in operation down to −253°C titanium alloys with up to 5 to 6% V are recommended. (P.C.H.)

840 AGING OF BERYLLIUM SINGLE CRYSTALS. Avotin, S. S.; Papirov, I. I. (Physical-Technical Inst., Kharkov). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 1-2, 178-9(1972).

Translated from Metalloved. Term. Obrab. Metal.; No. 2, 77-8 (Feb 1972).

Studies were made on the microhardness of hardened and aged Be of several degrees of purity. The microhardness was measured at room temperature on single crystals grown by zonal melting methods (purity about 99.98%) and by low cooling of the melt in a BeO crucible (purity about 99.7%). The specimens were hardened at 1000°C for 1 h and aged at 570 to 750°C for 0.5 to 50 h in vacuum of about 1×10^{-6} mm Hg. Hardening consisted of a rapid removal of specimens from the furnace. Aging of Be was accompanied by depletion of the matrix which is bound to reduce the hardness and to segregate the materials increasing the hardness. The segregation process speed and the degree of its completion depended on aging temperature and duration. The results suggest that the microhardness anisotropy grows with improving metal purity. (P.C.H.)

841 INVESTIGATION INTO THE PHASE STABILITY IN THE SYSTEMS IRON–TUNGSTEN–CARBON AND COBALT–TUNGSTEN–CARBON. Pollock, Charles Bruce. Raleigh, N. C.; North Carolina State Univ. (1972). 72p. University Microfilms Order 72-24,097.

Thesis.

Isothermal sections of the systems Fe−W−C and Co−W−C were investigated for ternary phases present and compositional ranges. The phases found in the Fe−W−C system at 1000°C include $Fe_6W_6C_6$ with a lattice constant of 10.956 to 10.958A and $Fe_3W_3C_3$ with a lattice constant ranging from 11.102 to 11.146A. A new ternary hexagonal phase FeW_3C was found and its lattice constants, a and c, were both equal to 7.806 to 7.810A. The Co−W−C system was found to contain two eta carbides with Co_6W_6C existing at all temperatures and a = 10.894 to 10.902A. The W_6C carbide has a narrow compositional range at 1000°C and spreads out to include Co_2W_4C and Co_3W_3C at 1400°C. The lattice constant varied between 11.066 and 11.251A. The hexagonal phase $Co_3W_3C_4$ reported by Schönberg (1954) was correctly placed at CoW_3C. (Diss. Abstr. Int., B)

842 SOLUTIONING AND AGING REACTIONS AND THEIR EFFECT ON HARDNESS AND MICROSTRUCTURE IN SOME NIOBIUM-BASE ALLOYS. Birla, Naresh Chandra. Cincinnati; Univ. of Cincinnati (1972). 233p. University Microfilms Order No. 72-23,591.

Thesis.

A study was made to investigate the solutioning and aging reactions and their effects on microstructure and hardness in twenty-four experimental niobium-base alloys, involving Nb−C, Nb−Si−C, Nb−15Hf−C, Nb−15Hf−C−Si, Nb−33Hf−C, and Nb−33Hf−C−Si systems. After selected heat treatments, the microstructural changes were determined by electron microscopy and the phases were extracted and identified by x-ray diffraction. The study involved more than 72 extractions and their analysis by x-ray diffraction, more than 135 solution treatments in an induction furnace, about 75 heat treatments for aging in a Brew furnace and more than 550 samples for polishing, metallography, and microhardness measurements. The aging reactions in the Nb−15Hf−C, Nb−15Hf−C−Si, and Nb−33Hf−C−Si alloys were characterized by precipitation of the complex monocarbide (Nb, Hf)(C, O, N) phase. Replacement of some of the carbon by silicon in the Nb−15Hf−1C alloys raised the overaging temperature from 800 to 1000°C and led to strength retention for longer times than the alloys which contained carbon only. However, the alloys in the Nb−33Hf−C system did not show precipitation hardening due to the precipitation of coarse Nb_2C particles during aging process. (Diss. Abstr. Int., B)

Radiation Effects

Refer also to abstracts 614, 1848, 1849, and 1860.

843 (ANCR-1078) COMPARISON OF THE FATIGUE AND CREEP-FATIGUE PROPERTIES OF UNIRRADIATED AND IRRADIATED TYPE 304 AND 316 STAINLESS STEEL AT 593°C (1100°F). Brinkman, C. R.; Korth, G. E.; Beeston, J. M. (Aerojet Nuclear Co., Idaho Falls, Idaho). Aug 1972. Contract AT(10-1)-1375. 50p. Dep. NTIS.

Results from fully reversed strain-controlled fatigue tests conducted at 593°C (1100°F) with and without tensile hold times on irradiated and unirradiated AISI 304 and 316 stainless steel are reported. Corresponding data from constant strain rate tensile tests conducted at the same temperature and strain rate are also given. Comparing data obtained from tests conducted on unirradiated Type 316 stainless steel in either the solution annealed or solution annealed and aged condition showed that aging was beneficial in improving both the fatigue and creep-fatigue properties at this temperature. An indication was found that unirradiated Type 304 stainless steel would be more suitable for applications involving creep-fatigue interaction than unirradiated Type 316 stainless steel. Irradiation to fluences of 0.17 to 6.1×10^{21} n/cm^2 E > 0.1 MeV (450°C) resulted in a pronounced effect on the creep-fatigue resistance of these materials when tested at a strain range of 1%. Data comparisons between irradiated and unirradiated, both aged and solution annealed, material were made by means of a time to fail versus number of cycles to failure diagram. Testing was also conducted on some specimens that had been cold-worked 11% prior to specimen fabrication. Little or no effect of cold-work was found for unirradiated Type 316 stainless steel. Creep and fatigue damage values were calculated using actual failure data and design criteria suggested by ASME Code Case 1331-5, and comparisons were made. Damage sums obtained were not found to be a unique value but dependent upon strain range, length of tensile hold time, and material condition. The inelastic strain developed during the various tests was partitioned into values resulting from creep and plastic flow for both irradiated and unirradiated material. Equations relating partitioned inelastic strain to cycle life for design estimates involving fully reversed hysteresis loops with creep flow in tension are given. Comparisons between estimates of irradiated fatigue behavior and actual irradiated fatigue lifetimes were made using limited data available. Estimates made using irradiated tensile data were usually found to be conservative in predicting pure fatigue behavior. Bilinear constants used for defining the cyclically hardened uniaxial stress-strain curve for the kinematic hardening model were also determined. (auth)

844 DIMENSIONAL STABILITY OF TANTALUM CONTROL RODS IN LMFBRs. Bates, J. F.; Pitner, A. L. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Technol.; 16: No. 3, 406-9(Nov 1972).

Available data on irradiation induced swelling in tantalum not exposed to flowing sodium has been used to derive the following empirical equation relating swelling to temperature and fluence:

$\%(\Delta V/V) = (\Phi t)^{0.4}$ [1.69 exp $\{-[T/100 - 11.75]^2/\alpha\}$ where $\%(\Delta V/V)$ = percent volume change Φt = neutron fluence n/cm², units of 10^{22} (E = 0.1 MeV) T = °F, $\alpha = \{14.87 + 44.57 \exp [0.005 (T - 1950)]\}/\{1 + \exp [0.005 (T - 1950)]\}$. Results of a brief review of the literature indicate that unclad tantalum control rods would not behave well in LMFBRs. (auth)

845 PRELIMINARY PLASTIC DEFORMATION ON THE DIFFUSION PROCESSES IN THE COPPER–ZINC SYSTEM DURING ELECTRON IRRADIATION. Pereverzev, D. D.; Markovskii, E. A. (Inst. of Foundry Problems, Kiev). Fiz.-Khim. Mekh. Mater.; 8: No. 2, 21-4(1972). (In Russian).

The effects of electron irradiation on diffusion processes in the Cu–Zn system were investigated at 200 to 400°C. A relationship was established between the degree of deformation of the matrix material and the intensity of the action of the electron irradiation on the velocity of increase of the β-phase in the Cu–Zn system. (tr-auth)

846 ZIRCALOY-2 CORROSION IN STEAM-WATER MIXTURE UNDER REACTOR RADIATIONS. Cerrai, E.; Gadda, F.; Scaroni, A. (Centro Informazioni Studi Esperienze, Milan). Can. Met. Quart.; 11: No. 1, 21-6(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Corrosion rates of Zircaloy-2 in steam–water mixture were studied in the following experimental conditions: out of pile at 285°C and 70 kg/cm²; under irradiation ($\Phi > 1$ MeV = 3.5×10^{12} n/cm² sec) at 285°C and 70 kg/cm²; under irradiation ($\Phi > 1$ MeV = 1.5×10^{13} n/cm² sec) at 285°C and 70 kg/cm²; and out-of-pile autoclave tests at 400°C and 105 kg/cm². Two closed-cycle loops were used for dynamic tests; most of the experiments were carried out in neutral conditions, that is, without any addition of chemicals to the feed water; only some preliminary tests were performed in an ammoniated environment. Experiments were conducted on corrosion coupons in as-pickled conditions; the exposure time for in-reactor tests was approximately 70 days. Results obtained on the corrosion of Zircaloy-2 samples showed that exposure to reactor radiation produces an enhancement in the oxidation rate, at least in the pretransition region, the extent of such an increase being related to the fast neutron flux. In the range of the fast neutron flux considered, the time to transition was found to be shortened by a factor of from approximately 10 to 50. For fractional hydrogen pickup no effect of reactor radiation was found. (auth) (Canada)

847 DEFORMATION PARAMETERS OF NEUTRON IRRADIATED ZIRCALOY-4 AT 300°C. Coleman, C. E.; Mills, D.; van der Kuur, J. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 91-100(1972).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Tensile tests at 300°C and structural examinations were carried out on specimens machined from annealed and cold-worked Zircaloy-4 fuel sheathing which had been neutron irradiated at 290°C. The stress-strain behaviour during testing at 300°C was related to the microstructures observed by transmission electron microscopy. The sizes of the barriers to dislocation motion were estimated with the maximum barrier diameter being about 22 Å. (auth) (Canada)

848 ANISOTROPIC CREEP BEHAVIOUR OF ZIRCONIUM ALLOYS IN A FAST NEUTRON FLUX. Ross-Ross, P. A.; Fidleris, V.; Fraser, D. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 101-11(1972). (AECL-4237).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

During fabrication, zirconium alloys develop strong crystallographic textures, which give the materials anisotropic properties. To derive the anisotropic factors which apply to creep deformation at relatively low stresses, temperatures of 260° to 300°C and fast neutron flux from 0.6×10^{13} to 3.5×10^{13} n/cm²s (>1 MeV), test results are analyzed using the effective stress and effective strain relations. The analysis is an extension of the conventional method representing the multiaxial stress state based on the generalized Von Mises yield function proposed by Hill. For the tubes evaluated the ratio of transverse creep in a closed-end tube to a uniaxial creep rate in the axial direction at the same stress, flux and temperature is about 0.3. The ratio of uniaxial creep rates in the transverse and axial directions is about 0.5. Tentative values for the anisotropic factors are determined for pressure tube materials which allow one to calculate strain behaviour under any stress state. The factors are broadly related to the inverse of the resolved fraction of prism planes oriented for slip. (auth) (Canada)

849 METALLURGICAL PROPERTIES OF HEAT-TREATED Zr–2.5 WT. PERCENT Nb PRESSURE TUBES IRRADIATED UNDER POWER REACTOR CONDITIONS. Langford, W. J.; Mooder, L. E. J.; Bryson, J. G. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Met. Quart.; 11: No. 1, 147-56(1972). (AECL-4236).

From International symposium on zirconium alloys; Montreal, Canada (31 Aug 1971). See CONF-710821.

Three heat-treated pressure tubes of Zr–2.5 wt % Nb were irradiated as components of Chalk River reactor loops under conditions similar to those in Canadian power reactors of pressurized heavy water (CANDU-PHW) and boiling light water (CANDU-BLW) type. Two other tubes, one of which had been artificially hydrided to about 200 ppM H_2, were irradiated unstressed in air at about 300°C. Post-irradiation examination of the tubes showed that they can withstand severe through-wall defects: the critical crack length exceeds 43 mm at a hoop stress of 179 MN/m² at 20° and 300°C. Mechanical strength was increased by neutron irradiation: eliminating autoclaving offers the advantage of lower rates of oxidation and hydrogen pickup. (auth) (Canada)

850 EVIDENCES FOR ENHANCED DUCTILITY DURING IRRADIATION CREEP. Nichols, F. A. (Bettis Atomic Power Lab., West Mifflin, Pa.). Contract AT-11-1-Gen-14. Mater. Sci. Eng.; 6: 167-75(1970). (WAPD-T-2252).

Building upon the mechanisms previously proposed for the creep deformation of zirconium alloys during neutron irradiation at temperatures $\lesssim$350°C, it is proposed that fracture ductilities greatly in excess of those obtaining out-of-pile should be observed. At low strain-rates (typically $\lesssim 10^{-6}$ h^{-1}) the strain-rate sensitivity, m, is rather large ($\geq$0.25) and fracture strains greater than those of unirradiated material have been observed. On the other hand, for fast strain-rates (typically $\gtrsim 10^{-4}$ h^{-1}) m → 0 after high degrees of irradiation and fracture strains accordingly become very small. The overall behavior is therefore analogous to the behavior of "Silly-Putty." The mechanisms of deformation believed responsible for this behavior involve the cutting (and destruction) of irradiation obstacles at the higher strain-rates (low m) and the radiation-enhanced circumventing of these obstacles at the lower strain-rates (high m). At still lower strain rates the gliding of dislocations becomes rate-controlling and m again decreases (m ~ 0.1). These concepts are in good agreement with available data. This work was performed as part of the LWBR Development Program. (auth)

851 DISLOCATION ATTENUATION IN MOLYBDENUM SINGLE CRYSTALS IRRADIATED BY ULTRASOUND. Belostotskii, V. F.; Kashevskaya, O. N.; Polotskii, I. G. (Inst. of Metal Physics, Kiev). Metallofizika; No. 39, 54-7(1972). (In Russian).

The dislocation attenuation in single crystals of Mo when subjected to ultrasound at 20 kHz was studied with regard to its dependence on vibration amplitude, time of exposure, and annealing temperature. The level of fading increased with increase in the vibration amplitude, but remained significantly smaller than after plastic deformation which would yield the same density of dislocations. Conversely, attenuation decreased during the irradiation of plastically deformed samples. Recovery of attenuation occurred in two temperature intervals: 75 to 150° and 250 to 600°C (between which a peak was observed at 210°C). The results are discussed in connection with the theory of Granato and Lucke. It was concluded that ultrasound irradiation together with an increase in dislocation density lead to a blocking of subsequent point defects more significantly than during plastic deformation. In this respect ultrasound radiation is analogous to the action of nuclear radiation or low-temperature annealing. (tr-auth)

852 INFLUENCE OF RADIATION DAMAGE BY FAST NEUTRONS ON THE STRESS CORROSION OF Fe–Cr–Ni STEELS. Schreiber, F. (Motoren- und Turbinen-Union GmbH, Munich); Engell, H. J. Werkst. Korros.; 23: No. 4, 255-9(1972). (In German).

The mechanical properties of chromium-nickel steels are changed by neutron irradiation. The stress-strain limit increases while the range of shear modulus decreases. A characteristic yield strength occurs for an integrated fast neutron flux of about 2.5×10^{19} n/cm² (E > 0.1 MeV) which increases the stress corrosion sensitivity. In the alloy Fe–19Cr–10Ni, there appear to be points of intercrystalline cracks. After neutron irradiation, the technical alloy has exclusively transcrystalline cracks which occur in a higher density, as compared to the pure alloy. (GF)

853 VOID SWELLING OF A γ-HARDENED ALLOY. Williams, K. R.; Fisher, S. B. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 15: No. 3-4, 243-50 (Aug 1972).

The swelling behavior of a γ′-hardened alloy was studied by

high-voltage electron microscopy. The rate of void swelling was found to be highly dependent on damage rate, temperature, and γ'-particle size. Significant swelling was only achieved at damage rates approaching 10^{-2} d/a/sec and at specific γ'-particle sizes. At small (≈30 Å) and large (>700 Å) particle diameters, the swelling rate was high. In the fully aged condition with particle diameters of the order 200 Å, the swelling rate was minimized. The mechanism of void swelling is attributed to the nonconservative climb of radioinduced dislocations. (auth)

854 BEHAVIOR OF VERY SMALL He-BUBBLES IN α-BOMBARDED ALUMINIUM. Ruedl, E.; Gautsch, O.; Staroste, E. (Commission of the European Communities, Ispra, Italy). Radiat. Eff.; 15: No. 3-4, 275-6(Aug 1972).

Direct observations were made on the behavior of He bubbles of ≲50 Å diameter in α-irradiated Al foils. Micrographs of bubbles were taken in selected contrast conditions after a first α irradiation. The same areas were photographed again at the best reproducible angle of inclination and in the same contrast conditions after a second α irradiation. Comparison of the micrographs showed general growth of the bubbles. There was no indication of shrinkage or complete dissolution of single bubbles. Estimations of the mean bubble diameter before and after the second α irradiation indicated bubble growth due to the additionally introduced He. (auth)

855 RADIATION- AND ANNEAL-HARDENING OF NEUTRON-IRRADIATED FERRITIC STEELS AND α-IRON. Milasin, N. (Boris Kidric Inst. of Nuclear Science, Belgrade). Radiat. Eff.; 15: No. 3-4, 153-65(Aug 1972).

Samples of low-alloy and low-carbon steels and of α-iron containing 30, 70, and 270 ppM C were neutron-irradiated at ambient temperatures, i.e., max 90°C for steels and max 40°C for α-iron. The doses varied from 5.5×10^{18} to 3.5×10^{19} neutrons/cm^2. The mechanical properties were measured before and after irradiation and after post-irradiation annealing at temperatures up to 500°C. Maximum hardening was observed in steels after annealing between 100 and 250°C, and in α-iron, between 100 and 125°C. Using TEM the structure of nonirradiated, irradiated, anneal-hardened, and recovered specimens was examined. It was concluded that radiation hardening as well as anneal hardening was mainly due to invisible defects. The increase observed in the yield stress was found to be consistent with the hardening by dislocation loops of ~20 Å in diameter, which act as weak barriers. Radiation-anneal hardening of α-iron was interpreted on the basis of the "strengthening" of radiation-induced defects by carbon atoms migrating above T_{irr}. In steels, the processes involved are much more complex and are influenced by a number of metallurgical and irradiation parameters. (auth)

856 EFFECT OF CHANNELING AND IRRADIATION TEMPERATURE ON THE MORPHOLOGY OF BLISTERS IN NIOBIUM. Kaminsky, M.; Das, S. K. (Argonne National Lab., Ill.). Appl. Phys. Lett.; 21: No. 9, 443-5(1 Nov 1972).

The morphology of blisters formed in monocrystalline and polycrystalline niobium samples under 0.5-MeV ^{4}He-ion impact at 900°C was studied. For the irradiated monocrystalline samples, the results reveal that the shape and size of the observed blisters are highly dependent on channeling conditions. (auth)

857 FRACTURE MECHANICS FOR HEAVY SECTION STEEL NUCLEAR PRESSURE VESSELS. Mager, T. R.; Riccardella, P. C.; Wessel, E. T. (Westinghouse Nuclear Energy Systems, Pittsburgh). Nucl. Eng. Des.; 20: No. 1, 181-200(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

The ability of a pressure vessel steel to resist fracture constitutes an important factor in ensuring nuclear reactor safety. In nuclear reactor pressure vessels some regions (belt-line) are subjected to irradiation damage. Irradiation hardening and embrittlement of mild steels are important in connection with the safety of reactor pressure vessels. Fracture mechanics is considered as providing the best general approach to understanding the brittle fracture phenomenon in reactor pressure vessel steels. Experimental testing of a group of reactor vessel steels utilizing Compact Tension (CT) specimens was performed to investigate the application of the fracture mechanics approach to these materials in the irradiated condition. Materials investigated include A533 grade B class 1 base plate and weldment. Compact-tension (CT) fracture mechanics specimens up to two inches in thickness (2T-CT) were irradiated at 550°F to a fluence of 1 to 5×10^{19} in/cm^2. Tensile and Charpy V-notch specimens from the same materials were also included in the irradiation package to provide correlation data. The fracture toughness of the irradiated pressure vessel material was determined by measurement of K_{I_c}, the critical stress intensity factor, which is considered to be a basic material property. The fracture toughness K_{I_c} for the unirradiated and post-irradiated conditions and the fatigue crack growth rate as a function of the change in stress intensity ΔK_I were utilized to demonstrate the integrity of heavy section nuclear reactor pressure vessels. The application of these parameters in conjunction with the normal coolant system design transients for a typical pressurized water reactor demonstrated that an initial allowable flaw size that could exist at the start of life would not grow to a critical size during the design lifetime of the nuclear reactor pressure vessel (40 years). (auth)

858 PENETRATION OF FAST ELECTRONS THROUGH MATTER. Tabata, T. (Radiation Center of Osaka Prefecture). Cyo Butsuri; 41: No. 3, 268-73(Mar 1972). (In Japanese).

Experimental results of penetration of fast electrons through thick materials are reviewed and comparisons with the calculated results of the Monte Carlo method are given. Experimental penetration factors were measured by the charge method for electrons up to 3 MeV. Calculated results by the Monte Carlo method were obtained by Berger et al. The agreement between the experimental and calculated results was good for 500 keV, ~3 MeV, and a little worse for 250 keV. Energy spectra and angular distribution of penetrated electrons through Be, Al, and Au were measured at the incident energy of 4 and 8 MeV. The results were mostly in agreement with the results of the Monte Carlo calculation. The same experiments were also performed by other workers using a Si(Li) detector. Good agreement with calculations was obtained. Distribution of charges in materials were observed for Be, Al, Cu, Ag, and Au. Monte Carlo calculations also showed good agreement with the experimental results, except for Be. Ranges in thick materials were also obtained and compared with the calculated results. A semi-empirical formula for the backscattering coefficient from thick materials was obtained. (Japan)

859 VARIATIONS OF THE INTERNAL FRICTION AND MODULUS DEFECT OF COLD-WORKED AND γ-IRRADIATED SILVER DURING RECRYSTALLIZATION. Isore, A.; Benoit, W.; Mercier, O. (Ecole Polytechnique Federale, Lausanne, Switzerland). Scr. Met.; 6: No. 10, 933-40(Oct 1972).

Results of experiments using polycrystalline Ag samples are presented. Data on evolution of internal friction as a function of annealing are presented for γ-irradiated samples. Results show that grain boundary migration rates are controlled by radioinduced defect production. (J.R.D.)

860 SURFACE OBSERVATIONS ON NICKEL ION-BOMBARDED STAINLESS STEELS. Johnston, W. G. (General Electric Co., Schenectady, N. Y.); Rosolowski, J. H.; Turkalo, A. M.; Challenger, K. D. Scr. Met.; 6: No. 10, 999-1005 (Oct 1972).

Anisotropy and inhomogeneity of swelling associated with the growth of voids in ion-bombarded stainless steels can be inferred from the surface structure of the bombarded metals. Results of bombardment of stainless steel specimens using 5-MeV nickel ions are reported. It was found that observed anisotropy in swelling is a manifestation of stress dependence. Microphotographs of bombarded specimens are included. (J.R.D.)

861 OXYGEN DIFFUSION DURING NEUTRON IRRADIATION. Boissier, Michele (CEN, Grenoble, France); Ligeon, Emile; Tousset, Jean. Compt. Rend., Ser. C; 274: No. 23, 1876-9(5 Jun 1972). (In French).

Considerable oxygen penetration was observed in niobium subjected to neutron irradiation. No similar diffusion was observed with nickel. Nuclear reactions were used to analyze this oxygen. (France)

862 INTERNAL FRICTION MEASUREMENTS ON NEUTRON-IRRADIATED Fe-3.48 PERCENT Ni ALLOY. Yamane, T.; Takahashi, J. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 10, 598-602(Oct 1972).

The Snoek peak and the strain-amplitude dependence of internal friction were measured in order to gain further information on the behavior of interstitial solute atoms in Fe−3.48% Ni alloy which had been neutron-irradiated and annealed. This alloy contained 37 ppM N and 7 ppM C. Interstitial solute N and C atoms were trapped by irradiation-induced defects and released by annealing at above 250°C. The Snoek peak and the slope of Granato−Lücke plots which latter is proportional to $1/L_c$ (L_c being the dislocation loop length between impurity atoms) increased with annealing temperature. The binding energy of interstitial solute N atoms to dislocations in the irradiated and annealed specimen was obtained from the strain-amplitude dependent internal friction. The value was about 16,500 cal/mole. (auth)

Other Materials

Refer also to abstracts 240, 277, 415, 1842, 2029, and 2030.

863 (BNWL–1672) HIGH-TEMPERATURE GRAPHITE IRRADIATIONS: 550 TO 1450°C. Morgan, W. C.; Gray, W. J. (Battelle Pacific Northwest Labs., Richland, Wash.). 19 Jun 1972. Contract AT(45-1)-1830. 78p. Dep. NTIS.

Radioinduced physical property and dimensional changes are presented on a wide variety of graphites irradiated at temperatures in the range from 550 to 1450°C and to neutron fluences up to 2.25×10^{22} n/cm^2 (E > 0.18 MeV). (auth)

864 (EUR–4751) PROCEEDINGS OF AN INFORMATION EXCHANGE MEETING ON RESULTS OF CONCRETE IRRADIATION PROGRAMMES, BRUSSELS, BELGIUM, APRIL 19, 1971. Benzler, H. (comp.) (European Communities, Luxembourg. Commission). May 1972. 99p. (In English and French). (CONF-710460). EUR B.Fr. 150.-.

Five articles are included: a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual papers see: 865–869.

865 (EUR–4751, pp 5-16) RADIATION DAMAGE IN CONCRETE: MEASUREMENTS ON MINATURE SPECIMENS OF CEMENT MORTAR. Pedersen, A. (Danish Atomic Energy Commission, Roskilde, Denmark). May 1972.

From meeting on results of concrete irradiation programmes; Brussels, Belgium (19 Apr 1971).

A preliminary irradiation experiment was carried out in order to get a first hand knowledge concerning the behavior of concrete under the influence of reactor radiation. It should be emphasized that the main purpose of the irradiation experiment was to get a survey of the problems involved in irradiation studies of concrete rather than to simulate power reactor conditions. The results may therefore not necessarily be directly applicable to the evaluation of a specific reactor vessel design. However, comparisons with the latest British experiments showed an amazing agreement. (P.C.H.)

866 (EUR–4751, pp 17-39) EFFECTS OF REACTOR RADIATION ON CEMENTS AND CONCRETE. Gray, B. S. (UKAEA, Risley Engineering and Materials Lab., Culcheth, Eng.). May 1972.

From meeting on results of concrete irradiation programmes; Brussels, Belgium (19 Apr 1971).

The effects of reactor radiation on high strength concretes, lightweight concretes, cements, and cement grouts are being studied in a materials testing reactor facility. Samples have also been exposed to γ radiation from spent fuel elements in an endeavour to separate the effects of neutron and gamma radiation on the physical properties and dimensions of the materials. The results to date are reviewed, and preliminary data on the effect of irradiation on the stress induced shrinkage of a cement grout are included. The results showed that in range of fast neutron doses of $10^{18} - 4 \times 10^{19}$ n · cm^2 pronounced changes can occur in both concretes and aggregates. The properties that changed in concrete were linear dimensions, strength, Young's modulus, thermal conductivity, and weight. Also the evidence favored the existence of an irradiation creep phenomenon and the possible importance of this must be considered. (P.C.H.)

867 (EUR–4751, pp 41-53) BEHAVIOR OF PLASTIC MORTAR SAMPLES UNDER TEMPERATURE AND RADIATION CONDITIONS. Cristiani, G.; Granata, S.; Montagnini, A. (AGIP Nucleare, Milan, Italy). May 1972.

From meeting on results of concrete irradiation programmes; Brussels, Belgium (19 Apr 1971).

The results of studies on thermal and reactor radiation effects on different concretes are reported. It was found that the highest operating temperature for a standard type of concrete was of the order of 300°C. The decrease of the compression strength of mortar was markedly less than that experienced by standard concrete; in an aggregate (limestone) no significant decrease in resistance was found. The hypothesis was made that the main factor responsible for the decrease of mechanical properties of concrete under thermal cycling was due to the formation of microcracks between cement and aggregate, caused mainly by their different thermal expansion coefficients. In the irradiation experiments no significant dimensional changes were noted. However, an increase in the dynamic elastic modulus and a decrease (10%) in the value of the flexural strength was found. It was concluded that radiation induced only a minor change in the essential properties of concretes at least at integrated neutron fluxes of some 10^{19} n · cm^{-2} and at temperatures of 150°C. (P.C.H.)

868 (EUR–4751, pp 55-69) EFFECT OF GAMMA IRRADIATION ON THE CREEP PROPERTIES OF CONCRETE. McDowall, D. C. (Central Electricity Research Labs., Leatherhead, Eng.). May 1972.

From meeting on results of concrete irradiation programmes; Brussels, Belgium (19 Apr 1971).

A set of 305 mm × 105 mm diameter cylindrical concrete specimens were monitored for creep and shrinkage under loading of 10 N/mm^2 and an average γ dosage of 11.4×10^3 rad/hr. The average temperature was 30°C. In conjunction with these specimens, measurements were taken on a control batch of cylinders under identical conditions of load and temperature, but with no irradiation. Comparison of the results after being under load for 10 months indicated the irradiated concrete had less creep than the control. The irradiated samples, however, exhibited higher shrinkage strains. (auth)

869 (EUR–4751, pp 71-98) EXPERIMENTS ON IRRADIATION OF CONCRETES AND THEIR CONSTITUENTS. Elleuch, M. F.; Dubois, F. (CEA, Centre d'Etudes Nucleaires, Saclay, France). May 1972. (In French).

From meeting on results of concrete irradiation programmes; Brussels, Belgium (19 Apr 1971).

Studies were made on the effects of neutron irradiation on concretes and their constituents. The results showed that irradiation always caused some variation in dimensions. Generally it was agitated by swelling. However, in the case of heat-insulating concrete containing dispersed clay bound by aluminous cement, a shrinkage due to irradiation was found. It is believed that the granules play a preponderant role in the dimensional behavior of the concrete under irradiation. In an analogous manner, the variations in the mechanical properties of the concretes under the effects of neutron irradiation were greatly influenced by the evolution of the mechanical characteristics of the granules. (P.C.H.)

870 (EUR–4867) RECOMMENDATION ON THE MEASUREMENT OF RADIATION-INDUCED DAMAGES IN REACTOR STRUCTURAL MATERIAL. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Aug 1972. 10p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 25,-.

The dosimetry of radioinduced damage in general and in graphite in particular is discussed. Other reports treating other materials and especially metals will be published later. The tentative numerical values of the annex may be subject to revision. (auth)

871 (GERHTR–32) VARIATIONS IN ANISOTROPY DUE TO IRRADIATION AND ANNEALING IN THE PYROLYTIC CARBON CLADDING LAYERS OF FUEL PARTICLES. Koizlik, K.; Balthesen, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of a German report. 10p. Dep. NTIS.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

Studies were made on the changes in the properties of pyrolytic carbon under different stresses by undertaking irradiation and annealing experiments directly on the particle cladding layers. The particles were irradiated with neutrons at doses of up to 16×10^{21} cm (E > 0.1 MeV) or at burnup levels up to 15% fima. In all cases the measurements showed an increase in the orientation anisotropy. The greater the neutron dose the greater the increase in anisotropy. The irradiation also caused an increase in the half-life widths of the distribution curves of the individual measurements. The changes appearing in the orientation anisotropy of the particle cladding layers revealed the decisive influence of the stresses, built up in the pyrolytic carbon. It was concluded from irradiation and burnup studies that the migration and annealing of vacancies give rise to rearrangement processes, which reduce the stresses and lead to an increased orientation anisotropy. The importance for fuel element development of the results presented and their interpretation as stress-enhanced graphitization processes may well be the fact that particles, compacted with graphite matrix materials, are capable of withstanding without damage higher neutron doses and burnup values than loose particles, since the cladding layers can be relieved of stress by the interaction between matrix and particle. (P.C.H.)

872 (TID–26196) LONG TERM CREEP BEHAVIOR OF CONCRETE AND THE EFFECTS OF CURING. Research Report 3661-2. Kennedy, T. W. (Texas Univ., Austin. Dept. of Civil Engineering). Jun 1972. Subcontract 3661. 49p. Dep. NTIS.

For Oak Ridge National Lab., Tenn.

The results of an experimental investigation to evaluate the

effects of curing time and history prior to loading on the instantaneous and creep behavior of concrete and the long-term creep behavior of concrete subjected to sustained loads for an extended period of time at 75°F are presented. The factors investigated were: curing time (90, 183, and 365 days); curing history (as-cast and air-dried); and uniaxial stress (660 and 2400 psi). The portion of the experimental investigation covered consisted of applying uniaxial compressive loads to cylindrical concrete specimens and measuring strains with vibrating wire strain gages that were cast in the concrete specimen along the axial and radial axes. Specimens cured for 90 days prior to loading were subjected to a sustained load for a period of one year, at which time the loads were removed; the specimens which were cured for 183 or 365 days, however, were not unloaded and have been under load for 2.5 and 2 years, respectively. The effects of each of the above factors on the instantaneous and creep behavior were investigated. In addition, the long-term creep behavior of the specimens cured for 183 or 365 days was evaluated. The findings of these evaluations are briefly discussed and summarized. (auth)

873 CORRELATIONS IN THE CATALYTIC ACTIVITY OF METALS IN THE GRAPHITE–OXYGEN REACTION. Harris, P. S. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 10: No. 5, 643-4(Oct 1972).

Activation energies for several metals, determined from data on the catalytic effect of impurities on graphite oxidation, and their correlation with lattice energies are briefly discussed. After considering changes in lattice energy in relation to ionization energy and latent heat of sublimation it was concluded that a genuine correlation between lattice energies of the monoxides and activation energies for the graphite-oxygen reaction was not established. (UK)

874 RADIATION-INDUCED DISCOLORATION OF GLASS MEDICINE BOTTLES. Huettenrauch, R.; Matthey, K. (Scientific Labs. of VEB Jenapharm, Jena, Ger.). pp 635-43 of Proceedings of the 2nd Conference on Applied Physical Chemistry. Vol. 2. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1971).

From second conference on applied physical chemistry; Veszprem, Hungary (2 Aug 1971). See CONF-710844–(Vol.2).

Radioinduced discoloration in five kinds of glass used for medicine bottles was studied. The glass specimens were exposed to γ radiation at a dose of 10 Mrad, then stored at 5°, room temperature, 57°, 65°, 80°, and 100°C in an area protected from light. Discoloration was followed kinetically for one month. Extinction values in the visible domain are plotted. Visible discoloration was the strongest in brown glass, followed in decreasing order by Jenatherm N, Jenatherm G, Rasotherm, and Jenatherm S glass. Results indicate that glasses rich in boric acid are preferred in the case of sterilization of drugs by radiation; the extent of blackening decreases with an increase in boric acid content. (J.G.B.)

875 OXYGEN TRANSFER AND CARBON GASIFICATION IN THE REACTION OF DIFFERENT CARBONS WITH CO_2. Grabke, H. J. (Max-Planck-Institut fuer Eisenforschung, Duesseldorf). Carbon; 10: No. 5, 587-99(Oct 1972).

The oxidation of carbon in CO_2-CO mixtures can be discussed assuming the mechanism: (1) $CO_2 = CO + O(adsorbed)$, (2) $O(adsorbed) + C \rightarrow CO$. This treatment is supported and supplemented by measurements of both partial reactions at different carbons, electrode graphite, charcoal, natural graphite, and iron doped graphite. From the kinetics it can be seen that the reactions (1) and (2) predominantly take place at different sites. Nevertheless the kinetics of both reactions were correlated, since a uniform oxygen activity was established at the carbon surface by the interplay of the oxygen surface diffusion and of both reactions. The rate of reaction (2) and accordingly the rate of the overall reaction was proportional to the stationary oxygen activity which can be calculated from the steady state condition for oxygen adsorption. Several rate equations were derived for the overall reaction at special reaction conditions and for different carbons, and it was found that no general explicit rate equation can be given for the oxidation of carbon in CO_2. (auth)

876 BINARY SYSTEMS CONTAINING RUBIDIUM AND CESIUM CHLORIDES AND URANIUM TETRACHLORIDE. Desyatnik, V. N.; Raspopin, S. P.; Chervinskii, Yu. F. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 120-1(1972). (In Russian).

Melting point diagrams were constructed for the two binary systems $RbCl-UCl_4$ and $CsCl-UCl_4$ by differential thermal analysis. The first system contained the four compounds $2RbCl \cdot UCl_4$, $3RbCl \cdot 2UCl_4$, $RbCl \cdot UCl_4$, and $RbCl \cdot 3UCl_4$, and two eutectics: 22.0 mole% UCl_4 (535°C) and 57 mole% UCl_4 (345°C). The second system contained three compounds: $2CsCl \cdot UCl_4$, $3CsCl \cdot 2UCl_4$, and $CsCl \cdot UCl_4$, and two eutectics: 63 mole % UCl_4 (356°C) and 17.0 mole % UCl_4 (522°C). (K.S.W.)

877 LEAD INTERACTION WITH CHLORIDE MELTS CONTAINING URANIUM AND MOLYBDENUM. Vasin, B. D.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 3, 122-3(1972). (In Russian).

The reaction of metallic lead with a melt consisting of NaCl + KCl + $MoCl_3$ + UCl_4 at 700°C in an argon atmosphere resulted in the reduction of Mo^{3+} to metallic Mo, and of U^{4+} to U^{3+}. Quantitative studies with melts of various initial compositions were made. (K.S.W.)

878 PILOT PLANT STUDIES OF RADIATION INDUCED EMULSION POLYMERIZATION OF VINYL CHLORIDE. Prehoda, George Stephen. Raleigh, N. C.; North Carolina State Univ. (1971). 128p. University Microfilms Order No. 72-26,298. Thesis.

A flow reactor system is used to study the radiation induced emulsion polymerization of vinyl chloride. Emulsion solution is recirculated from a stirred vessel through relatively long transfer lines to a tubular reactor located within a high intensity ^{60}Co irradiator. The pilot plant is equipped for temperature measurement and control for operating both above and below room temperature. Constructed from standard stainless steel tubing and fittings, the system is modular in design and can be adapted easily to changes in configuration. The effect of certain engineering variables such as agitation rate, recycle flow, and flow rate on the rate of polymerization is investigated. The effect of physical chemical variables such as temperature, phase ratio, soap concentration, and dose rate on the rate of polymerization is also investigated. The system is found to be suitable for the study of the variables mentioned above. The rate of polymerization is found to be proportional to the 0.26 power of the emulsifier concentration. The rate shows a proportionality to the agitation rate to the -0.51 power. The rate increases with an increase in temperature over the range 15 to 50°C. The activation energy based on the rate is found to be 3.4 kcal/mole. The rate is found to be independent of the flow rate when operated in continuous mode at a residence time less than 1.5 minutes. The rate is independent of the phase ratio up to 23 percent and then it begins to fall off. A slight post effect is found and autoaccelerating characteristics are in evidence for typical conversion curves. (Diss. Abstr. Int., B)

879 PROCESS FOR THE PRODUCTION OF CARBON FIBRES. Redfarn, Cyril Aubrey (to Imperial Chemical Industries Ltd.). British Patent 1,283,714. 2 Aug 1972. Filed 9 Jul 1969.

Some disadvantages associated with the use of polymeric materials in the production of carbon fibers are stated, and a process is described that substantially overcomes these disadvantages. In this process a polymeric material that has been radiation crosslinked is employed. Fibers of this material are heated in an oxidizing atmosphere to oxidize the material, and then heated in an inert atmosphere to a temperature sufficient to substantially carbonize the fibers. Crosslinking ensures that the polymeric material remains in fibrous form during heating in the oxidizing atmosphere. The carbonized fiber may be graphitized by heating at a sufficiently high temperature. The polymeric material may be a polyolefin or a polyvinyl halide, and the fiber undergoes little or no longitudinal shrinkage. Examples are described. (UK)

880 PAINT TO REDUCE ^{41}Ar RELEASE AND RESIDUAL ACTIVITY IN A REACTOR EXPOSURE VOLUME. Leonard, B. E. (Inst. for Resource Management, Bethesda, Md.); Penny, C. D.; McManaman, V. L. Health Phys.; 23: No. 2, 239-40 (Aug 1972).

A paint was developed to be used during modification of an exposure room of the AFRRI–TRIGA reactor facility to reduce the slow neutron fluence in the room. The paint incorporated gadolinium oxide as a pigment, styrene acrylate as a binder and butyl benzolpthalate as a plasticizer and aromatic solvent. The paint was tested for hardness and durability and exposed to the mixed neutron and γ-ray field in the reactor exposure room to determine thermal neutron attenuation factors, capture-γ-ray absorbed-dose contributions during exposure, and residual β and γ ray absorbed dose rates as a function of time after exposure. From these data it was shown that the use of the special paint with Gd_2O_3 pigment effectively reduced the ^{41}Ar production by a factor of 30 and the residual activity in the room by at least a factor of 10 with only a minor change (less than 20%) in the fast-neutron and gamma-ray tissue-absorbed dose environment in the room. The paint in the reactor exposed room has resisted peeling for a 3-year period in a thermal neutron fluence field up to about 10^{15} neutrons/cm^2. (UK)

881 COMMENTS ON THE EFFECT OF FAST NEUTRON IRRADIATION ON THE TENSILE STRENGTH OF CARBON

FIBERS. Jones, B. F.; Peggs, I. D. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Radiat. Eff.; 15: No. 3-4, 279-81 (Aug 1972).

Carbon fibers were irradiated in the test facilities of the WR-1 organic-cooled reactor at temperatures above 400°C. The mechanical properties and various structural parameters of the fibers were studied before and after irradiation. Neutron fluences are quoted with reference to a threshold energy of 0.18 MeV. High-modulus (HM) and high-strength (HS) fibers were studied: these were similar to the ones described by Bullock (Rad. Effects, 11, 107 (1971)). It was found that the mechanical properties of both types of carbon fiber can improve or worsen depending on the irradiation temperature and fluence. The results are compared with those reported previously, and alternative mechanisms are suggested to account for the effects observed. (UK)

882 STUDIES ON THE MANUFACTURE OF LOW DEGREE OF POLYMERIZATION PULPS BY IRRADIATION. 3. THE IRRADIATION METHOD FOR PULPS ON A LARGE SCALE. Ueno, Takeo (Sanyo Pulp Co. Ltd., Iwakuni, Japan); Murakami, Masahiro; Imamura, Rikizo. Kami Pa Gikyoshi; 25: No. 9, 465-74(Sep 1971). (In Japanese).

Samples of dissolved pulps were irradiated using a cobalt-60 slab gamma source (125 kCi), high energy (2 MV), and low energy (0.5 MV) electrons from accelerators. The degree of polymerization (DP) at various points in the irradiated pulp samples was measured and from these values the absorbed dose distributions in the samples were calculated by means of an empirical equation which expresses the relationship between absorbed dose and extent of depolymerization. By reference to the absorbed dose distribution the optimum irradiation methods were established for the manufacture of low DP pulps, taking into consideration the uniformity of irradiation, the utilization efficiency of radiation, and the production capacity. Results showed that cobalt-60 slab sources are inapplicable. High-energy electron accelerators are expected to produce low DP pulps having desirable properties when applied with electron filters and/or irradiation on both sides. These irradiators, however, have defects in that capital investments for power increase and complicated handling to stack pulp sheets are required. For the low-energy accelerators, it is possible to improve the uniformity of irradiation and the efficiency of radiation by incorporating backscattering. For example, in the case in which Pb-plates are adopted as the backscattering materials, the ratio of maximum-to-minimum absorbed dose in pulp sheets amounts to 1.1 and the utilization efficiency of radiation reaches 95%. Moreover, they can be installed at the ends of the common pulp machines, so that very low irradiation cost can be expected. (auth) (Japan)

883 MECHANISM OF STRUCTURE MODIFICATION AND PROPERTIES OF ORIENTED MATERIALS BY THE METHODS OF GRAFT AND BLOCK COPOLYMERIZATION. Kurilenko, A. I. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk SSSR; 203: No. 5, 1078-81(11 Apr 1972). (In Russian).

Experiments were conducted as a systematic approach to the problem of modification of the properties of materials through graft and block copolymerization. Using infrared spectroscopy, polarized light, double refraction methods, polyacrylonitrile, polyvinylidene chloride, and polymethylmethacrylate grafts in 30 μ films of polyethylene were studied after the action of γ rays in a vacuum. About 10^{17} free radicals/cm^3 were generated by the γ rays in the polyethylene which was maintained in vapors of the desired monomer until the desired amount of grafting occurred. Certain aspects of the mechanism involved were deduced from the changes in thermomechanical and mechanical properties. (K.S.W.)

884 IMPROVEMENT OF POLY(VINYLCHLORIDE)-INSULATED WIRE BY ELECTRON BEAM IRRADIATION. Kamada, Osao; Nakamura, Kon-ichi; Itabashi, Hideo; Takashima, Takuji; Maeda, Masami (Hitachi Cable, Ltd., Ibaraki, Japan). Hitachi Hyoron; 54: No. 2, 148-52(Feb 1972). (In Japanese).

Methods for improving the thermal and mechanical characteristics of polyvinylchloride insulated wire by means of electron-beam irradiation were investigated. It is hard to crosslink polyvinylchloride by irradiation without adding polyfunctional monomers. So the addition effects of polyfunctional monomers as well as various plasticizers on the crosslinking were studied. An insulating core transformer-type electron accelerator was used for the irradiation. Gel production effects of various polyfunctional monomers were determined. The effects of the molecular weight of polyvinylchloride on the gel production were also studied. The effect was greater, the larger the molecular weight. Characteristic properties of the polyvinylchloride insulated wire, e.g., tensile strength, aging characteristics, deformation by heat, contraction by heat, penetration property against a soldering iron, and electric characteristics were observed. It was found that the polyvinylchloride insulated wire had better thermal and mechanical characteristics than the usual heat-resisting vinyl insulated wire. Electric properties of the polyvinylchloride insulated were the same as those of the usual vinyl insulated wire and were sufficient for the practical use. (Japan)

885 ELECTRON BEAM CURING OF COATINGS. Kobayashi, Juichi; Ide, Fumio (Mitsubishi Rayon Co. Ltd., Tokyo). Nippon Secchaku Kyokai Shi; 7: No. 6, 348-60(Dec 1971). (In Japanese).

Electron beam curing of coatings is a fast curing method at room temperature. Long pot-life, 100% reactive materials are used as coatings. It is suitable for fast coating of such base material as inorganic fiber and metal plates as well as for woods and plastics unsuitable for high-temperature heating. Compared with the conventional heat curing method, it has advantages including reduction of installation area, startup and shutdown time and man-power, improvement of working conditions, and less environmental pollution. Special features in the polymerizing and crosslinking reactions, principally of unsaturated polyester resin, are described. The structure of the coatings suitable for electron beam polymerization and crosslinking and their recent trend are briefly surveyed. Finally, several problems are indicated concerning high-speed treatment ability of electron accelerators. Though it is still in the primary stage, this method is a strong future technique, and appears to be a pioneer in the development of electron beam processing. (Japan)

886 POLYPHENYLENE OXIDE AND ITS USES AS MATERIAL IN EXPERIMENTS AT NUCLEAR REACTORS. Soyka, W.; Erdtmann, G. (Kernforschungsanlage, Juelich, Ger.). Kerntechnik; 14: No. 8, 337-42(Aug 1972). (In German and English).

PPO is a polyphenylene oxide plastic possessing ideal properties for many reactor experiments. The highly temperature-resistant type PPO C 1001 is particularly suitable for use as a packing and structural material. A particularly pure grade was developed in which the radioactivity induced by neutrons remains very low. Thermal shape stability extends to 190°C, where resistance to irradiation is higher than polyethylene. (auth)

887 RADIATION MODIFICATION OF COTTON FABRICS. I. CROSSLINKING COTTON USING MULTIFUNCTIONAL MONOMERS. Nasr, Hussein I. (National Research Centre, Cairo). Tex. Res. J.; 42: No. 8, 497-9(Aug 1972).

The results of a series of experiments attempting to improve the crease-recovery properties of cotton fabrics are given. This was successfully realized by crosslinking cotton cellulose, using multifunctional monomers initiated by gamma radiation, alone or combined with a delayed heat cure. Parameters were radiation dose, initial monomer concentration, mixed monomer systems, and effect of a delayed heat cure. The results showed a significant improvement in wrinkle resistance of treated fabrics, with practically no loss in tensile strength. (auth)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

888 (BNWL-SA-4275) USE OF ISOTOPIC COMPOSITION DATA TO IMPROVE REACTOR CALCULATIONAL TECHNIQUES. Carter, N. E.; Christensen, D. E.; Prezbindowski, D. L. (Battelle Pacific Northwest Labs., Richland, Wash.). 20 Mar 1972. Contract ACDA/WEC-216. 22p. (CONF-720455-3). Dep. NTIS.

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

Before the availability of isotopic data from chemical reprocessing of spent nuclear fuels, burnup code normalization was done using data from small burnup samples. Chemical reprocessing plant isotopic data are an additional source of burnup data reliably measured to permit normalization of calculational code processes to real data. By applying isotopic correlation techniques to this source of data and to data from burnup calculations, it appears that procedures are available (a) to detect code input errors, (b) to detect calculational biases in both U and Pu isotopes, and (c) to diagnose calculational weaknesses. A means whereby the maximum use of dissolution data is realized is given. (auth)

889 (KFK-1583) USER'S MANUAL FOR THE APPLICATION OF THE DYNAMIC PROCESS INVENTORY DETERMINATION USING ISOTOPIC STEP SIGNALS IN REPROCESSING PLANTS. Drosselmeyer, E.; Kraemer, R.; Rota, A. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1972. 50p. (EUR-4727; CONF-720455-1). Dep. NTIS (U. S. Sales Only).

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

The technical feasibility and procedures of a dynamic nuclear material process inventory technique is described which correlates isotopic composition data of subsequent input and product batches in reprocessing plants. This technique was developed for the application in safeguards with the objective to calculate the nuclear material balance at time intervals during a running campaign. The manual is divided into 7 chapters covering preprocess information requirements on the material balance area and the spent fuel to be processed, optimization procedures for the generation of adequate isotopic step signals, and the procedures to determine, with the help of the actual measured input and product signal, the physical inventory of nuclear material. This inventory is compared with the corresponding book inventory by suitable statistical procedures (Monte Carlo technique) in order to obtain the Material Unaccounted For (MUF) and its range of uncertainty. The annexes give a short description of four computer codes for suitable data handling of this inventory technique. (auth)

890 (LA-DC-72-977) ^{252}Cf NEUTRON SOURCE SYSTEMS FOR THE ASSAY OF URANIUM AND PLUTONIUM IN FUEL RODS. Menlove, Howard O. (Los Alamos Scientific Lab., N. Mex.). 1972. 9p. (CONF-720902-5). Dep. NTIS.

From National topical meeting on the applications of californium-252; Austin, TX. (11 Sep 1972).

Two assay systems are described which utilize ^{252}Cf neutron sources for the measurement of fissile content in reactor fuel rods. The first system uses thermal neutron interrogation to induce fission reactions in the fuel rod and fast neutrons from the induced reactions are counted using energy-biased ^{4}He-gas recoil detectors to give the total fissile content in the rod. In addition, to obtain the desired spatial resolution for pellet-to-pellet measurement, a small NaI detector to measure the delayed gamma-ray response has been positioned near the fuel rod exit port of the ^{252}Cf shield. Using a 400 μg ^{252}Cf source, the counting rate in the ^{4}He detector is ~6000 cps and the rate from the NaI detector is ~95,000 cps for a PWR-type rod (3.3% enriched). To measure fuel rods with high fissile density such as FFTF rods, thermal neutron interrogation has inadequate penetration and a fast neutron irradiation system has been built. This system uses large NaI detectors positioned near the ^{252}Cf shield to measure the delayed gamma rays from the sample. Measurements on FFTF-type fuel rods gave net signal rates >4000 cps for detector bias energies $\geq$1.2 MeV using a 600 μg ^{252}Cf source. (auth)

891 (NP-19431) PROCESS INVENTORY DETERMINATION BY ISOTOPIC TECHNIQUES (SAFEGUARDS APPLICATIONS). Ewing, R. A. (Battelle Columbus Labs., Ohio). 31 Mar 1972. Contract ACDA/WEC-214. 50p. (CONF-720455-6).

From Meeting on the use of isotopic composition data in safeguards; Vienna, Austria (10 Apr 1972).

Application of a new technique for determining the physical inventory of plutonium or uranium within the process line of a fuel reprocessing plant without a shutdown and flushout is described. The technique, which is analogous to an isotope dilution analysis, employs the unique isotopic compositions of different lots of fuel. One lot (the inventory) is displaced by fuel of another, different isotopic composition. By analyzing isotopically the product mixture containing the inventory, its quantity can be calculated, knowing the isotopic compositions of both lots of material. The technique was experimentally demonstrated during the recent reprocessing of Humboldt Bay reactor fuel at the Nuclear Fuel Services plant, using data supplied by the reprocessor. Although the uniformity of the isotopic composition of the processing batches comprising both the inventory and the displacing fuel was below desirable limits for an isotopic process inventory determination, a useful experiment was nevertheless possible. In-process inventories were determined at two different times during the reprocessing campaign. Material unaccounted for (MUF) values based on these inventories were 1.9% and 1.5%, respectively, of input. MUF for the whole campaign, determined by conventional techniques after a flushout, was 0.8% of input. The differences between isotopically and conventionally derived MUF were not much larger than the quantities recovered by the post-campaign flushout. The limits of error of the book inventory are large compared to those estimated for the isotopic process inventory and hence, as with the end-of-campaign MUF, dominate the limits of error for MUF. (auth)

Disposal and Storage

Refer also to abstracts 214 and 314.

892 (ARH-2548) ENGINEERING STUDY: ALTERNATIVE EVAPORATIVE FACILITIES FOR THE B TANK FARM COMPLEX. McKnight, J. P. (Atlantic Richfield Hanford Co., Richland, Wash.). 22 Jun 1972. Contract AT(45-1)-2130. 21p. Dep. NTIS.

Since startup, the ITS #2 bottoms system for solidifying the Hanford B tank farm wastes has not performed as satisfactorily as was originally anticipated. Therefore, a study was made to determine a more efficient operating evaporator than the ITS #2 unit and/or to provide a solid product whereby the available solids storage capacity in the B tank farm complex could be utilized. The following alternative evaporating schemes were investigated for incorporation into the B tank farm bottoms system: spray drying, forced circulation vacuum crystallization-evaporation, forced circulation atmospheric evaporation, and natural circulation atmospheric calandria evaporation. The results of this study indicate that spray drying using the 102-BY bottoms tank as a containment vessel is the most attractive process for eliminating ITS #2 operational problems and at the same time utilizing all the solids storage tanks available in the B tank farm complex. It produces the best quality product (potentially a 1 to 5% moisture content) of all the processes studied. The solids product would be conveyed pneumatically to other tanks in the B tank farm complex for storage. It can be installed more quickly and at a low capital cost, 0.5 to 0.7 million dollars. (T.D.)

893 (DEMO-72/11) STUDY OF LEACHING KINETICS OF IONS FROM "WASTES" INCORPORATED IN BITUMEN. Amarantos, S. G.; Petropoulos, J. H. (Democritus Nuclear Research Center, Athens (Greece)). Jul 1972. 31p. Dep. NTIS (U. S. Sales Only).

A study of the kinetics of leaching of Na^{+} and Ca^{2+} ions by water from simulated bituminized wastes is reported. The samples tested were prepared by incorporating a mixture of salts chiefly in emulsified asphalt of various types to the extent of 50% by weight. The leaching process is described by Fick's equation of diffusion extended to take into account explicitly the dissolution of salt in water-filled pores in the bituminized block, which precedes diffusion to the outside. It was found that the added dissolution term is important in determining the leaching kinetics of sparingly soluble salts. The result obtained with the most hydrophobic emulsified asphalt employed was found to accord with the theoretical predictions for simple cases (constant pore structure), including the predicted difference in kinetics between soluble (Na^{+} in the form of $NaNO_3$ and NaCl) and sparingly soluble (Ca^{2+} in the form of $CaCO_3$) salts. More complicated results were obtained with blocks prepared from more hydrophilic emulsified asphalts. This more complex behavior could nevertheless be

understood qualitatively to a large extent in terms of changes in the pore structure of the block (due to swelling etc.) during leaching. Furthermore, the most hydrophobic emulsified asphalt employed appeared suitable for the practical disposal of wastes of moderate radioactivity. (auth)

894 (ORNL–4827) HYDRAULIC FRACTURING TEST AT WEST VALLEY, NEW YORK. de Laguna, Wallace (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 69p. Dep. NTIS.

A test was conducted to determine the geometry of fractures formed hydraulically in flat-lying Devonian shale in western New York. Five wells were drilled—an injection well at the center and four observation wells 150 ft out to the east, north, west, and south. All five wells were 1500 ft deep and were cased through their full depth. The first test was the injection of about 100,000 gal of water at 1450 ft into rock classed as fair for the formation of horizontal fractures. Indications from the pumping pressure, which was low, were that a horizontal fracture had formed, but there was some doubt, as the results differed from those for a similar test at Oak Ridge where the fractures are known to be horizontal. Analysis of the pressure decay after pumping had stopped suggested a horizontal fracture. A second injection at 1450 ft of water containing a radioactive tracer was shown to have formed a group of horizontal fractures. A third injection at 1226 ft, into rock classed as good for the formation of horizontal fractures, was shown by logging of the observation wells to have formed a single horizontal fracture. The pressure decay also suggested a horizontal fracture. The fourth injection was at 1010 ft into a massive siltstone that was classed as poor for the formation of horizontal fractures, where a vertical fracture was predicted. The tracer showed that a thin horizontal fracture had formed, but that the main part of the injected water had fractured downward to 1395 ft. Analysis of the pressure decay curve showed no indication of any fracture except the thin horizontal one at 1010 ft. Two injections were made at 500 ft into rock classed as good for the formation of horizontal fractures. The first was plain water. Again, the injection pressures were low. The pressure decay curve suggested a horizontal fracture, but the interpretation was not clear. The second injection at 500 ft consisted of water, portland cement, and bentonite, as a permanent uplift of the surface was desired. Logging of the observation wells showed that a horizontal fracture had been formed. It was concluded that horizontal fractures are to be expected in horizontally bedded shale down to depths of 1500 ft and that the only reliable way to determine fracture orientation is by the use of a radioactive tracer and observation wells. (auth)

895 (UCRL–73818) PLACEMENT AND SELF-PROCESSING OF NUCLEAR FUEL REPROCESSING WASTES IN DEEP UNDERGROUND CAVITIES. Lewis, A. E.; Cohen, J. J.; Braun, R. L.; Rothman, A. J. (California Univ., Livermore. Lawrence Livermore Lab.). Aug 1972. 21p. (CONF-721107–1). Dep. NTIS.

From Symposium on the management of radioactive wastes from fuel reprocessing; Paris, France (27 Nov 1972).

A method is presented for disposing of nuclear fuel reprocessing wastes by in situ incorporation in molten silicate rock. In this method, liquid wastes are injected into a deep underground cavity and allowed to self-boil. The resulting steam is processed at the ground surface and recycled in a closed system. When waste addition is terminated, the chimney is allowed to boil dry, thereby solidifying the waste. The heat generated by the radioactive waste then melts the surrounding rock, which dissolves the waste. Finally, the rock refreezes, trapping the radioactivity in an insoluble rock matrix deep underground. This method has significant environmental and economic advantages over previously proposed methods. (auth)

896 TREATMENT AND DISPOSAL OF LOW-LEVEL RADIOACTIVE SLUDGES BY SOLAR EVAPORATION. Lee, Sang Hoon (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 4: No. 3, 194-202(Sep 1972).

In this investigation, a solar evaporation method was studied to reduce the water content of the radioactive sludge produced from the clay adsorption liquid waste treatment. The solar method to form sludge cake from sludge slurry could economically reduce the sludge volume, thereby, lowering the cost of sea disposal about 8%. (auth)

897 SELECTION OF A SITE FOR THE GROUND DISPOSAL OF RADIOACTIVE WASTES. I. AN APPROACH TO SAFETY ANALYSIS. Inoue, Y.; Morisawa, S. (Kyoto Univ.). Nippon Genshiryoku Gakkaishi; 14: No. 10, 522-30(Oct 1972). (In Japanese).

Disposal of radioactive solids or solidified wastes in the ground is at present forbidden in Japan, mainly because of the difficulties in the evaluation of the migration of leaked radionuclides and of the radiation dose to which the public would be exposed by the disposed wastes. First of all, the behavior and the migration of radionuclides in the environment are quantitatively expressed. Then, the internal dose rate received by the public is estimated under suitable assumptions. Ten radionuclides contained in radioactive wastes and three ecological paths of the nuclides in the environment are discussed (i.e., the paths through drinking water, sea foods, and vegetables). It is concluded that the critical nuclides in this disposal scheme are ^{90}Sr and ^{110m}Ag, and that the internal dose is mainly governed by the intake through vegetables. The safety of the ground disposal of radioactive wastes is also evaluated. (auth)

Handling Equipment and Procedures

Refer also to abstracts 880 and 2001.

898 (Y-DR–86) DOUBLE-BATCHING CELL LOADINGS IN STORAGE ARRAYS OF FISSILE MATERIALS. Thomas, J. T. (Oak Ridge Y-12 Plant, Tenn. (USA)). 31 Oct 1972. Contract W-7405-eng-26. 25p. Dep. NTIS.

Monte Carlo calculations of reflected cubic arrays of U(93.2) spherical units are reported in which the influence of unit reactivity on the array neutron multiplication factor is studied. Perturbations to an array by increasing the mass of one or more units are examined as a function of the mass of the unit, the cell dimension, the number of units in the array, and the array neutron multiplication factor. Conditions are stated which define when double batching one or more units in a subcritical reflected array will not lead to criticality. (auth)

899 ESTIMATING THE RISK INVOLVED IN TRANSPORT OF HAZARDOUS MATERIALS. Garrick, B. J.; Baldonado, O. C.; Geckler, W. C. (Holmes and Narver, Inc., Los Angeles). pp 11.1-26 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

A model was developed for quantitatively estimating the risk when handling and transporting hazardous materials. The estimated risk values can be used to evaluate the effectiveness of changing the container design, handling procedures, method and path of transport, as well as testing and inspection procedures. The ultimate objective is minimization of public exposure when transporting hazardous materials such as radioactive materials, chemicals, biological products, and other toxic substances. Only materials capable of atmospheric diffusion are considered. The measure of risk calculated is the expected number of people affected by the hazardous material. The model calculates the probability of release and the expected area affected by various dose levels or concentrations given that there is a release of hazardous material. Coupling the population density with the areas gives the risk measure. Many factors are considered in estimating the effect of a hazardous material release. Two distinct time decay constants can be used corresponding to whether the material is inside or outside the transport container. These decay constants account for the change in activity of the materials while in storage and the effect of atmospheric properties such as solar radiation, humidity, and heat. Reduction factors are included in the model to account for barriers around the container which preclude release of hazardous materials. The portion of material released to the atmosphere is then calculated by combining the preceding factors with the leakage rate and aerosolization factor for the material/container system. The expected areas subjected to various concentrations or dose levels of the hazardous materials are calculated. Diffusion equations are used to determine the concentration distribution after the release. The concentration numbers for each area are related to the probability of biological harm to humans. Probabilities are computed for events (accidents, container leaks, environmental control system failures) leading to a release at any point in the transport path, the path being divided into nodes and links. Vehicular types and accident frequencies are assigned to each path element. The probability is calculated by a Monte Carlo technique. In effect, this technique simulates the interaction of handling procedures and transportation mode with the container design during the time intervals established by the transport path. By multiplying the probability of release, expected areas for various concentrations, the probability of biological harm, and the population density, a measure of risk is obtained. Some numerical results of the

methodology are given to illustrate the use of the model to determine the effect of changing container design, path, transit time, and mode of transport. (auth)

Transportation

900 (ARH–2038) DROP TEST; NYASDA CAPSULE. Curren, E. F. (Atlantic Richfield Hanford Co., Richland, Wash.). May 1970. Contract AT(45-1)-2130. 21p. Dep. NTIS.

The New York State Atomic and Space Development Authority (NYASDA) designed and placed in service, capsules for the storage and shipment of plutonium nitrate solutions contained in ten-liter vented polyethylene bottles. The capsules and contents were transported in L-10 shipping containers under Department of Transportation permit SP-5061. Drop tests were performed at Hanford with the capsule pressurized with air to 35 psig to simulate the pressure buildup which might be expected during transit from New York State to Hanford. The following observations were made: the capsule used in the test leaked gas from a pressure of 35 psi to 26 psi on the first drop. The deceleration was approximately 34 g; at a deceleration force of approximately 17 g (second drop) leakage of gas from the capsule did not occur; on the third drop, where the deceleration force exceeded 300 g, the capsule failed. Gas pressure and solution were both lost to the specification 2-R pressure vessel; and the specification 2-R pressure vessel, without the protection of the shipping container, did not leak on any of the three drops. It was demonstrated under the test condition; 27-foot drop, flange end of specification 2-R down, that the protection afforded the polyethylene bottle by the NYASDA capsule is marginal under the Annex 2 Hypothetical Accident conditions of AEC Mc 0529 Appendix, that plutonium nitrate solution would likely be released to the interior of the Specification 2-R pressure vessel whether or not the bottle was enclosed in a capsule, and that any loss of solution to the specification 2-R pressure vessel would be contained safely. (T.F.D.)

901 (UCRL–51195) ANALYSIS OF THE NEUTRON SHIPPING CONTAINER, MODEL 4T. Hanson, C. L.; Coops, M. S.; Quigg, J. D. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Apr 1972. Contract W-7405-eng-48. 44p. Dep. NTIS.

A safety analysis is reported for the Livermore Laboratory model 4T shielded shipping cask. The cask is designed to safely transport all isotopes of americium, berkelium, californium, curium, einsteinium, and fermium in solid form. (T.F.D.)

PARTICLE ACCELERATORS

Design, Development, and Operation

902 (ACRH-1000-353) ARGONNE CANCER RESEARCH HOSPITAL CYCLOTRON. Harper, P. V.; Skaggs, L. S.; Porter, J.; Lembares, N.; Forsthoff, H.; Krizek, H.; Lathrop, K. A.; Kuchnir, F. (Argonne Cancer Research Hospital, Chicago, Ill.). Jul 1972. Contract AT(11-1)-69. 11p. (CONF-720717-9). Dep. NTIS.

From sixth international cyclotron conference; Vancouver, B. C. (18 Jul 1972).

The installation of a cyclotron (Cyclotron Corp. CS-15) in an existing building without disruption of other operations was accomplished with relatively little difficulty using overdesigned shielding (6 feet of ordinary concrete). Background measurements on a whole-body counter 50 feet away on the same floor were increased only 10% summing over the whole spectrum. Available space in the vault is 18 × 13 feet, permitting convenient operation of a 3-port target facility oriented vertically. The operating responsibility has been entirely in the hands of personnel without previous experience, with engineering and physics back-up when needed for repairs, maintenance and improvement of the machine. The targetry has been handled almost entirely by the operating staff. During the first three years of operation, down time has been insignificant (~10%), almost equally divided between component failure and operator error. Applications have been in the production of radionuclides for experimental and clinical use. ^{66}Ga and ^{67}Ga were produced by proton and deuteron bombardment of zinc using an internal target. ^{18}F was produced using the ^{20}Ne(d,α)^{18}F reaction which proved to be substantially more efficient than the alternative ^{16}O(^{3}He,p)^{18}F reaction. ^{13}N as $^{13}NH_3$ was produced by deuteron bombardment of methane as described by Tilbury at Sloan-Kettering. This material has been most useful for imaging the myocardium. ^{111}In, ^{11}C, and ^{15}O are also in production, as well as a number of other nuclides. The possibility of using the deuteron reaction (8 MeV) on beryllium to produce fast neutrons for therapy is currently being explored. In the present configuration, which includes independent control of the harmonic coils, 100 of 160 μA of deuterons have been extracted for this purpose. (auth)

903 (RLO-2041-71) PARTICLE ACCELERATION BY INTENSE COHERENT ELECTROMAGNETIC WAVES. Csonka, P. L. (Oregon Univ., Eugene). 25 May 1972. 131p. Dep. NTIS.

It is suggested that an accelerator can be built in which particles are accelerated by intense bursts of monochromatic electromagnetic radiation of wavelength λ. Such radiation can be produced by lasers, and is modified by a general optical element called a "template." The template is a phase controlled holograph, but often it can be a simple holograph. Accelerating and focusing field elements have dimensions comparable to λ; a high degree of miniaturization and fields comparable to intraatomic ones result. A laser with 10^{14} Watts instantaneous power and 2.10^2 cm coherence length can accelerate a particle to 180 GeV in 2 meters. At energy $\xi = 10^2$ GeV, transverse acceptance of $\pi \cdot 10^{-5}$ to $\pi \cdot 10^{-7}$ cm · rad, energy acceptance for protons $\Delta\xi \approx 5$ GeV (much larger for electrons), and instantaneous beam currents of about 100 A can be expected. No magnets or metallic structures are needed near the beam: induction effects are reduced. High fields allow reduction of machine size and acceleration time: there is no need for long vacuum tunnels, the beam has to stay stable only for short times, vacuum requirements can be relaxed, and unstable particles (and heavy ions) can be accelerated. Due to the large acceleration, the beam cross section will tend to shrink. Synchrotron radiation has a similar effect. Positive and negative particles can be accelerated simultaneously. To reach higher energies, several lasers are used and joined by "synchronizers." All information about the accelerating fields is in the laser and the template. If the template is a holograph, it can be reproduced photographically. Then, if a laser is available and a new accelerator is needed, one does not have to build a new machine, it suffices to photograph an old one. (auth)

904 IMPROVING THE VACUUM CONDITIONS IN TESTING CHARGED-PARTICLE ACCELERATORS IN TEST BENCHES. Pankratov, V. G.; Piskalov, L. M.; Ogorodnikov, S. N.; Orlov, R. V.; Belinskii, V. N. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 170-2(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 149-51(1972).

The results are presented of investigating the possibility of using high-energy beams of charged-particle accelerators to improve the vacuum conditions in test benches. (auth)

Auxiliaries and Components

905 (LA-DC-72-1132) PERFORMANCE OF LAMPF COMPUTER CONTROL SYSTEM. Butler, Harold S. (Los Alamos Scientific Lab., N. Mex.). 1972. 11p. (CONF-721029-1). Dep. NTIS.

From third all-union national conference on particle accelerators; Moscow, USSR (2 Oct 1972).

The control system for the 800-MeV proton linac at the Los Alamos Meson Physics Facility is organized about an on-line digital computer. Over 8500 data and control signals are connected to the computer through an interface system which allows many operations to proceed in parallel. The accelerator can be run from either of two identical consoles serviced by the computer. The organization of the control system, the way it functions, and the manner in which an operator uses the system from the central control room are described. Several application programs that have had an important impact on the operation of the facility are discussed. Also a brief report on developments in the beam switchyard is presented. (auth)

906 (RHEL/R-254) ANALYSIS OF THE 100 kW REACTOR REGULATOR SET WITH THE MAGNET LOAD TYPE Q425. Jaroslawski, S. (Rutherford High Energy Lab., Chilton (England)). Apr 1972. 31p. Dep. NTIS (U. S. Sales Only). UK 2s. 6d.

The behavior of the 100 kW reactor regulator with a magnet load is analyzed to explain and correct evident instability. The root locus analysis exposes the critical conditions of the derived transfer functions and highlights the areas within the regulator which have to be investigated if better performance is to be achieved. An attempt is made to improve the behavior of the regulator by modifying the existing network. An analog computer is used to simulate the step function response of the 100 kW regulator before and after the realization of the corrective measures. (auth)

Ion Sources and Injection and Extraction Systems

Refer also to abstract 911.

907 (COO-7-645) DUODEHCATRON: A GENERAL PURPOSE NEGATIVE AND POSITIVE ION SOURCE. Richards, H. T.; Klody, G. M. (Wisconsin Univ., Madison). 1972. Contract AT(11-1)-Gen-7. 6p. (CONF-720948-8). Dep. NTIS.

From 2nd international conference on ion sources; Vienna, Austria (11 Sep 1972).

The DUODEHCATRON is a DUOplasmatron type Direct Extraction ion source which replaces the filament with a Hollow Cathode Arc running on argon gas. A 3 mm aperture between cathode and intermediate electrode permits use of a gas in the anode region which is different from the argon on which the hollow cathode arc runs. A 100 liter/min forepump differentially pumps the cathode region. This separation of anode and cathode gases allows use of anode gases or vapors which would poison the filament emission of an ordinary duoplasmatron. Off-axis extraction of negative ions formed by dissociative attachment of the anode gas or vapor gives intense and bright beams of negative ions. Beams of ≥ 100 μA H^- and ≥ 10 μA of BH_4^-, NH_2^-, O^-, OH^-, F^-, Cl^- have been produced. On-axis extraction of positive ions gives the normal bright and intense beams of a duoplasmatron. The source was installed for routine use on the University of Wisconsin tandem accelerator. (auth)

908 (DNPL/NSF/R-2) SOME PREDICTIONS OF STRIPPER YIELDS FOR THE PROPOSED 20/30 MV NUCLEAR STRUCTURE FACILITY TANDEM ACCELERATOR. Price, H. G. (Daresbury Nuclear Physics Lab. (England)). 1972. 17p. Dep. NTIS (U. S. Sales Only).

The results are presented of a study of the charge state distributions of heavy ion beams after passage through gas and foil strippers and in particular their implications on the energies and intensities of heavy ion beams from the proposed 30 MV tandem Van de Graaff accelerator. The semi-empirical expressions used are briefly discussed together with the expected accuracy of their predictions. The optimum positions of strippers in a multiple stripper system for maximum output beam energy from the accelerator are obtained. The energies and intensities of heavy ion beams produced with a two and a three stripper sys-

tem are compared. The necessary radius of the 90° magnet required to analyze the beams produced with these stripper systems is examined. (auth)

909 (FRNC-CONF-59) STATUS REPORT ON AXIAL INJECTION IN THE GRENOBLE CYCLOTRON. Belmont, J. L.; Bois, J. M.; Ferme, J. (Grenoble Univ. (France). Institut des Sciences Nucleaires). 1972. 6p. (CONF-720717-8). Dep. NTIS (U. S. Sales Only).

From sixth international cyclotron conference; Vancouver, B. C. (18 July 1972).

The channel, electrostatic deflector, buncher and pulser of the Grenoble cyclotron injection system for injection of multicharged heavy ions are described in detail. (France)

910 (LA-DC-72-1019) PRE-BUNCHING IN A LAMB-SHIFT POLARIZED ION SOURCE. Lawrence, G. P.; Koelle, A. R.; McKibben, J. L.; Clegg, T. B.; Roy, G. (Los Alamos Scientific Lab., N. Mex.). 1972. 6p. (CONF-720948-3). Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

A method for pre-bunching the beam in a Lamb-shift polarized ion source to conserve the beam intensity for time-of-flight experiments is described. The modulation requirement, buncher circuit, and bunching tests and results are discussed. (W.H.K.)

Ion Optics and Field Calculations

911 (DNPL/NSF/P-1) SIMULATION OF HEAVY ION SCATTERING AT STRIPPERS IN BEAM OPTICS CALCULATIONS FOR TANDEM VAN DE GRAAFF ACCELERATORS. Joy, T. (Daresbury Nuclear Physics Lab. (England)). Feb 1972. 13p. Dep. NTIS (U. S. Sales Only).

A procedure is worked out which enables the scattering of heavy ions at strippers to be explicitly incorporated into beam optics calculations for tandem Van de Graaff accelerators. The method is applicable to the phase space ellipsoid type of calculation or ray tracing. An example is given of the use of the procedure with an interactive beam optics computer program. (auth)

912 (DNPL/NSF/R-3) INTERIM REPORT ON BEAM OPTICS CALCULATIONS FOR THE NUCLEAR STRUCTURE FACILITY. Joy, T.; Lisle, J. C.; Phillips, W. R. (Daresbury Nuclear Physics Lab. (England)). 1972. 41p. Dep. NTIS (U. S. Sales Only).

A report is given of beam optics calculations for the Nuclear Structure Facility which is a tandem Van de Graaff accelerator. Background on the development of the proposals and the relation to previous accelerator optics studies is given. With attention limited to d.c. beams, a comprehensive first order optics study is described which incorporates small angle scattering at strippers and the effects of multiple charge state beams. The proposed layout is shown to be feasible and flexible and compatible with the acceleration of the full range of ion species for the operating voltage range of the machine. (auth)

913 (JINR-P9-6555) CALCULATION OF THE ACCUMULATION OF IONS IN THE ELECTRON RING OF A COLLECTIVE ACCELERATOR. George, V.; Iovnovich, M. L.; Novikov, V. G.; Preizendorf, V. A.; Rubin, N. B.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Calculations of the accumulation of ions in an electron ring are presented. The following cases are examined: (a) ion buildup from a gaseous medium during ring compression, and (b) ion accumulation in an already contracted ring from continuous and pulsed jets of gas atoms. (tr-auth)

914 (JINR-P11-6579) CALCULATION OF TWO-DIMENSIONAL MAGNETIC FIELDS IN THE PRESENCE OF THE MEDIA WITH NONLINEAR MAGNETIC CHARACTERISTICS. Derendyaev, Yu. S.; Klenin, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The technique of calculation of two-dimensional static magnetic fields in nonlinear media based on the difference approximation of the initial differential equation is described. On the basis of this technique the FORTRAN program is developed that allows plane-parallel and axial-symmetrical magnetic fields to be calculated. The results of calculation of the cyclotron electromagnet and the magnetic screen of a ringtron are presented and compared with experiment. (auth)

915 STATISTICAL PROPERTIES OF MAGNETIC BREMSSTRAHLUNG OF ELECTRON BUNCHES IN SYNCHROTRONS. Naugolnyi, N. N. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 660-3(Apr 1972). (In Russian).

The influence of small phase perturbations of an electron bunch on statistical properties of synchrotron radiation is studied. The photon field of a single electron is shown to have the Poisson statistic. When the bunch consists of more than one electron, the jump of photon dispersion is observed that results in time correlation of photons. (auth)

Storage Rings

916 (BNL-17172) CONSIDERATION OF THE RF SYSTEM FOR THE 15 GeV ELECTRON RING OPTION FOR ISABELLE. Allen, M. A.; Rees, G. H. (Brookhaven National Lab., Upton, N. Y.). 7 Aug 1972. 8p. (CRISP-72-68). Dep. NTIS.

In considering the rf system, the parameters used are based on tentative ring design. The choice of frequency depends on rf power consideration and values of synchrotron oscillation frequencies. Changes in the lattice parameter can influence the synchrotron frequencies and the peak voltages necessary to contain quantum fluctuations. At the present time, the favored frequency is ~400 MHz, where the peak voltage is 38 MV. At the design current of 100 mA, the total rf power requirement is ~3 MW. (F.S.)

917 (BNL-17173) BYPASS LAYOUT OF ISABELLE PROTON AND ELECTRON RINGS AND STUDY OF e-p INTERACTION REGION. Steffen, K. (Brookhaven National Lab., Upton, N. Y.). [nd]. 9p. (CRISP-72-70). Dep. NTIS.

A bypass-layout of the ISABELLE storage rings to allow decoupling while setting up beams and experiments is described. The layout has the following features: the straight sections of the proton rings are increased to 500 m providing a circumference length three times that of the AGS; the increased length is used to switch the beams into either one or two bypasses with minimum bending; the electron ring is inside the proton rings at a smaller radius; and for e-p interaction, the beam is guided into a bypass that intersects one or both of the proton rings. (F.S.)

918 (BNL-17279) HIGH-TRANSITION ENERGY LATTICE. Garren, A. (Brookhaven National Lab., Upton, N. Y.). 8 Sep 1972. 4p. Dep. NTIS.

The possibility of making a storage ring lattice with high transition energy if a very short bunch length is desired is discussed for storage rings with a modest rf voltage. The scheme employs reverse bending magnets in the regular lattice. (W.H.K.)

Experimental Facilities

Refer also to abstracts 364, 367, and 368.

919 FOILS AND FILMS OF THALLIUM ISOTOPES FOR NUCLEAR RESEARCH. Nazarova, T. S.; Rozen, A. A. (Physical-Technical Inst., Kharkov). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 15: No. 1, 255(1972).

Translated from Prib. Tekh. Eksp.; 15: No. 1, 217(1972).

A procedure is described for obtaining films of ^{205}Tl and ^{203}Tl isotopes having a thickness of from 0.3 to 5 mg/cm^2 on a Dacron substrate and free foils from 5 mg/cm^2 up by vaporizing a compact sample on a Dacronor zinc substrate. The vaporization was carried out from a tantalum vaporizer at a rate of 3 to 4 mg/min at 1070°K. The films and the foils were used to study the decay of isomers which develop in reactions with α-particles. (auth)

920 APPARATUS FOR STUDYING NUCLEAR REACTIONS WITH POLARIZED ^{3}He NUCLEI. Zaika, N. I.; Nemets, O. F.; Pavlovets, G. P.; Semenov, V. S.; Yasnogorodskii, A. M. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 155-7(Jan 1972). (In Russian).

Apparatus is described for investigating nuclear processes with polarized nuclei ^{3}He. Polarization of the gaseous target ^{3}He was implemented by optical pumping. The polarization obtained amounted to 23% at a pressure of 1 mm Hg, and 12% at 4.5 mm Hg. (tr-auth)

921 UNISOR: A CORPORATE UNIVERSITY ISOTOPE SEPARATOR INSTALLED "ON-LINE" AT THE OAK RIDGE HEAVY ION ACCELERATOR. Hamilton, J. H. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 143-54(Jan 1972). (In Russian).

The isotope separator "UNISOR" has been installed in conjunction with the isochronous cyclotron ORIC at Oak Ridge, Tennessee, for research by a number of southern universities. Arrangement of ion source-targets, the system of ion-optic lenses, the mass-separator magnet, focal and collector chambers, and other features of the complete assembly are summarized. Projected plans for research with UNISOR are described. (K.S.W.)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstract 1292.

922 (NP-19366) WORK SUMMARY. Mejia, Gaston R. (ed.) (Universidad Mayor de San Andres, La Paz (Bolivia). Laboratorio de Fisica Cosmica). May 1971. 343p. (In Spanish). Dep. NTIS (U. S. Sales Only).

The results of a series of studies made in Bolivia on the physics of high energy particles, cosmic showers, modulation of cosmic rays, high atmospheric meteorology, and application of solar radiation to other areas of science are presented in a synthetic form. The studies presented include a preliminary analysis of the cosmic ray storm of January 26, 1968, the density gradient of cosmic rays perpendicular to the ecliptic plane, anisotropies of cosmic rays perpendicular to the ecliptic plane, observations of high energy nuclear explosions in Chacaltaya, accompanying energetic nucleons in the atmosphere, high stability instruments for the investigation of the angular distribution in the galaxy of charged particles with energies between 10^{13} to 10^{14} eV, coincident radiopulses, lateral distribution of radiopulses in Chacaltaya, simultaneous observations in Chacaltaya of three frequencies of radiopulses, abnormal component of atmospheric muons, re-examination of the abnormal zenithal distribution, zenithal distribution of atmospheric muons of Chacaltaya, variation of the pressure in Chacaltaya, exploitation of solar energy, the "El Alto" radioprobe station and its physical parameters, neutron monitor, and meson telescope. (J.S.R.)

923 (ORNL-TM-3961) CALCULATIONS OF NEUTRON FLUX SPECTRA INDUCED IN THE EARTH'S ATMOSPHERE BY GALACTIC COSMIC RAYS. Armstrong, T. W.; Chandler, K. C.; Barish, J. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 39p. Dep. NTIS.

Calculations have been carried out to determine the neutron flux induced in the Earth's atmosphere by galactic protons and alpha particles at solar minimum for a geomagnetic latitude of 42°N. Neutron flux spectra in the energy range from $\sim 10^{-8}$ to $\sim 10^{5}$ MeV at various depths in the atmosphere were calculated using Monte Carlo and discrete ordinates methods, and various comparisons with experimental data are presented. The magnitude and shape of the calculated neutron-leakage spectrum at the particular latitude considered support the theory that the cosmic-ray-albedo-neutron-decay (CRAND) mechanism is the source of the protons and electrons trapped in the Van Allen belts. (auth)

924 PRIMARY COSMIC γ RAYS ABOVE 10^{12} eV. Wdowczyk, J. (Inst. of Nuclear Research, Lodz, Poland); Tkacyk, W.; Wolfendale, A. W. J. Phys., A (London); 5: No. 9, 1419-32(Sep 1972).

An analysis is made of the interactions of very energetic cosmic-ray primaries with the universal blackbody radiation in extragalactic space. The γ rays from the initial π^0 mesons produce electron pairs in collisions with further blackbody photons and a γ-e cascade builds up through this interaction and the inverse Compton interaction. Results are given for the expected γ-ray spectrum at the earth for a variety of assumptions about the magnitude of the primary spectrum and other parameters and comparison is made with upper limits to the γ-ray intensity from experimental data. One conclusion that arises immediately is that if the higher of the two primary proton energy spectra is correct then the extragalactic infrared energy density must be less than about 2 eVcm^{-3}. In general the predicted γ to proton ratios are highest in the region of 3×10^{19} eV. They are mostly below present detection limits but should be detectable with the improved extensive air shower arrays at present being constructed. (auth)

925 MOMENTUM SPECTRUM OF MUONS AT SEA LEVEL IN THE RANGE 5 TO 1200 GeV/c. Nandi, B. C.; Sinha, M. S. (Regional Engineering Coll., Durgapur, India). J. Phys., A (London); 5: No. 9, 1384-94(Sep 1972).

The momentum spectrum of sea-level cosmic-ray muons was measured for near vertical incidence in the range 5 GeV/c < p < 1200 GeV/c by the Durgapur cosmic-ray spectrograph. The measured spectrum compared well with that predicted from the pion diffusion model based on the assumption of 100% pions as the parent of muons. The exponent of the pion production spectrum was determined to be $-2.61^{+0.03}_{-0.02}$. The results were compared with the results of other workers. (auth)

926 COSMIC-RAY SPECTRAL MODULATION ABOVE 2 GV. IV. THE INFLUENCE ON THE ATTENUATION COEFFICIENT OF THE NUCLEONIC COMPONENT. Bachelet, F.; Iucci, N.; Villoresi, G.; Zangrilli, N. (Univ., Rome). Nuovo Cim.; 11B: No. 1, 1-12(11 Sep 1972).

The influence of the primary cosmic-ray modulation on the attenuation coefficient of the nucleonic component at different latitudes and altitudes was studied. The direct investigation of the time behavior of the station attenuation coefficients was based on the largest amount of refined data so far used, i.e. the revised data of the IGY neutron monitors 1957-1965 obtained in Part I and the IQSY supermonitor data 1965-1969. The results of the correlation between this time behavior and the time changes of the nucleonic intensity were in agreement with the estimates based on the solar-cycle modulation of the primary spectrum found in Part III. The results are also presented in a form suitable to their use for an accurate pressure correction of the data of the network of neutron monitors. (auth)

927 CURRENT STUDIES OF EXTENSIVE AIR SHOWERS BY THE NOTTINGHAM GROUP AT HAVERAH PARK. Blake, P. R.; Ferguson, H.; Nash, W. F. (Univ. of Nottingham, Eng.). J. Phys. Soc. Jap.; 33: No. 5, 1197-1206(Nov 1972).

The Haverah Park Array detects extensive air showers which are produced by primary particles with energies greater than 10^{17} eV. The whole project, which is a collaboration between four British Universities, is to determine the mass composition and sources of these cosmic rays. This paper is concerned with the study of muons in large showers, carried out by the Nottingham group. The investigation uses three multilayer flash tube muon detectors of area 12 m^2. The mean muon density is determined as a function of shower size, core distance, and zenith angle and compared with model calculations. The relative response of muon and Cherenkov detectors has also been compared with the results of model calculations. This is a more sensitive parameter and it is found that only three types of models are in reasonable agreement with experimental data. (auth)

928 OBSERVATIONS OF GALACTIC COSMIC-RAY INTENSITY AT HELIOCENTRIC RADIAL DISTANCES OF FROM 1.0 TO 2.0 ASTRONOMICAL UNITS. Van Allen, James A. (Univ. of Iowa, Iowa City). Astrophys. J.; 177: No. 2, L49-52 (15 Oct 1972).

From observations with the Jupiter-bound spacecraft Pioneer 10 it is found that the integral intensity of the galactic cosmic radiation ($E_p > 80$ MeV) varied by less than 3 percent (either plus or minus) over the heliocentric radial range 1.0–2.0 au during the epoch 1972 March–July. (auth)

929 HIGH-ALTITUDE COSMIC-RAY-NEUTRON INTENSITY VARIATIONS. Soberman, Robert K. New York; New York Univ. (1955). 130p. University Microfilms Order No. 72-24,545.

Thesis.

Three groups of balloon flights carrying boron trifluoride counters were made from geomagnetic latitudes 10.1°N, 55.1°N, and 88.6°N. From the data obtained, curves of neutron intensity versus atmospheric depth for depths less than 700 mb are plotted. The mean absorption lengths for neutrons in the equilibrium portion of the atmosphere were found to be L(10.1°) = 212 gm/cm^2, L(55.1°) = 164 gm/cm^2, and L(88.6°) = 164 gm/cm^2. The depths of the neutron intensity maxima were found to be θ_{max}(10.1°) = 120 ± 5 mb, θ_{max}(55.1°) = 100 ± 5 mb, and θ_{max}(88.6°) = 75 ± 5 mb. From these results and those of other investigators, the variation of the mean absorption coefficient ($\mu = 1/L$) and the depth of the neutron intensity maximum are plotted as functions of the geomagnetic latitude. A family of curves of neutron intensity versus atmospheric depth is drawn for geomagnetic latitudes at 10 degree intervals between 0° and 90°N and from this the low energy neutron capture per square centimeter per second by the ^{14}N(n,p) reaction in the atmosphere is calculated and plotted as a function of geomagnetic latitude. It is found that the observed neutron intensity varies by about 420 percent from 0° to 90°N. A value of 5.8×10^{18} sec^{-1} is obtained for the total number of low energy neutrons captured in the atmosphere. (Diss. Abstr. Int., B)

930 ENERGY SPECTRUM OF ATMOSPHERIC NEUTRONS. Gabbe, John D. New York; New York Univ. (1956). 261p. University Microfilms Order No. 72-24,486.

Thesis.

A series of airplane flights during which boron-trifluoride neutron counters were carried to an altitude of 7 meters water equivalent (10,000 feet) was made in the vicinity of New York, New York (52°20′ North Geomagnetic Latitude) in the summer of 1955. The fillings of some of the counters consisted of boron-trifluoride gas enriched with the isotope ^{10}B; the remainder of the counters

contained boron-trifluoride gas of the normal isotopic ratio. Various shields were placed around some of the counters. These shields were of cadmium, tin, Pyrex glass, and lime glass. The "$1/\sqrt{E}$-thin-detector" assumption cannot be applied to the Pyrex-shielded counters used in the experiment, because the Pyrex shield was sufficiently thick to display large second-order effects. The ratios of the counting rates of the variously shielded counters are compared with the theoretically calculated ratios after the experimental ratios have been corrected for the effect of the aircraft. The ratios calculated theoretically are obtained by using the energy-distribution function $n(E)\,dE = B\,x^3\,dE\,\exp[-0.388\,x + 0.003,43\,x^2 - 0.000,048,2\,x^3 + \ldots.]$ derived by Freese and Meyer. The neutron-production data reported by Davis and by Staker, who used Pyrex-glass-envelope boron-trifluoride counters, are corrected for the measured absorption of neutrons by the ^{10}B in the Pyrex; and the neutron-production rates are recalculated using more recent values for the neutron cross sections in the equations. The corrected neutron-production rates, (2.1 ± 20%) neutrons per cm^2 per second at 54.7° North Geomagnetic Latitude and (0.9 ± 20%) neutrons per cm^2 per second at 30.4° North Geomagnetic Latitude, agree within 5 percent with the results recently reported by Soberman. Within the limits of accuracy of this experiment, the energy-distribution function of Freese and Meyer is found to describe the energy spectrum of atmospheric neutrons. (Diss. Abstr. Int., B)

931 HOW REAL IS THE TOKYO AIR SHOWER EVENT OF ENERGY 4×10^{21} eV? Subramanian, A. (Tata Inst. of Fundamental Research, Bombay). Curr. Sci. (India); 41: No. 17, 629-30(5 Sep 1972).

It is pointed out that the recently reported extensive air shower (EAS) event by the Tokyo group need not necessarily be assigned as energy of 4×10^{21} eV. An alternate interpretation leads to an estimate as low as 10^{18} eV. It is suggested that all the other reported EAS of energy $\sim 10^{20}$ eV could be scaled down to a limit of this order. (auth)

932 GALACTIC-LATITUDE DEPENDENCE OF LOW-ENERGY DIFFUSE X RAYS. Yentis, D. J.; Novick, R.; Vanden Bout P. (Columbia Univ., New York). Astrophys. J.; 177: No. 2, 375-86(15 Oct 1972).

A flux of low-energy diffuse x rays was observed which was qualitatively well correlated with 21-cm column densities of hydrogen from intermediate to high galactic latitude. The intensity exceeds that predicted by an extrapolation to low energies of the power-law spectrum observed above 1 keV. The observed x-ray intensity and the apparent correlation with interstellar hydrogen were accounted for by an additional component of extragalactic radiation plus a local component. For the latter, one cannot exclude the possibility that the x-rays are produced in the upper atmosphere. In addition, a large flux of x rays was observed near the galactic plane and a prominent feature in the constellation Gemini. (auth)

933 POSITIVE DETECTION OF AN EXCESS OF LOW-ENERGY DIFFUSE X RAYS AT HIGH GALACTIC LATITUDE. Yentis, D. J.; Novick, R.; Vanden Bout, P. (Columbia Univ., New York). Astrophys. J.; 177: No. 2, 365-73(15 Oct 1972).

Data in the energy range 0.10 to 0.28 keV were obtained which confirms the existence of a soft diffuse x-ray flux exceeding in intensity an extrapolation to low energy of the spectrum determined at energies above 1 keV. It is shown that these data are completely free from contamination by ultraviolet and charged-particle events. To guard against these systematic effects, a rocket payload incorporating x-ray optics and filters was used. The x-ray spectrum incident at the Earth is shown to be steeply rising at energies less than 0.28 keV, with an integrated energy flux between 0.10 and 0.28 keV of 29.2 keV s^{-1} cm^{-2} $sterad^{-1}$. (auth)

934 HIGH-ENERGY COSMIC GAMMA-RAY OBSERVATIONS FROM THE OSO-3 SATELLITE. Kraushaar, W. L.; Clark, G. W.; Garmire, G. P.; (and others) (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 177: No. 2, 341-63(15 Oct 1972).

Final results from observations carried out in 1967–1968 with an instrument on the OSO-3 satellite confirm the discovery of cosmic γ rays with energies above ~50 MeV. The celestial distribution demonstrates the existence of a galactic component which is concentrated in a band of directions around the galactic equator with a broad maximum toward the galactic center. It also shows the existence of an isotropic component with a softer energy spectrum which is probably of extragalactic origin. Using calibration results derived from new measurements on the flight backup instrument, it was found for the integral equivalent line intensity above 100 MeV of the galactic center component in the region $-15° < b^{II} < 15°$, $-30° < l^{II} < 30°$ a peak value (isotropic component subtracted) of 1.3×10^{-4} $(cm^2\ s\ rad)^{-1}$, and for the general galactic component in the region $-15° < b^{II} < 15°$, $30° < l^{II} < 330°$ the value 3.4×10^{-5} $(cm^2\ s\ rad)^{-1}$. The intensity of the isotropic component was 3.0×10^{-5} $(cm\ s\ sterad)^{-1}$. (The known statistical and systematic uncertainty in these values was approximately 30 percent, but additional systematic uncertainty of a factor of 2 could not be excluded.) The galactic-latitude distribution of events away from the galactic center region matched the distribution predicted for the detector on the assumption that the general galactic intensity was proportional to the columnar density of interstellar neutral gas deduced from 21-cm radio measurements. The absolute intensity of this component could be accounted for if one assumes that γ rays with E > 100 MeV are produced by the π^0 process at a rate of 1.6×10^{-25} s^{-1} per atom of neutral hydrogen. (auth)

935 PROPAGATION OF COSMIC RAYS WITH Z ≥ 74. Schramm, David N. (California Inst. of Tech., Pasadena). Astrophys. J.; 177: No. 2, 325-39(15 Oct 1972).

The propagation of relativistic (energy $\gtrsim$ 1 GeV per nucleon) Z ≥ 74 cosmic rays was investigated. An r-process source was assumed, and effects due to spallation, fission, and radioactive decay (including time dilation) were included. In addition to the above-mentioned nuclear effects, ionization losses were explicitly put into the calculation. Cosmic rays in this region fall into four discrete groups: Pt group ($74 \leq Z \leq 80$), Pb group ($81 \leq Z \leq 83$), actinides ($90 \leq Z \lesssim 100$), and the SH (superheavy) group ($Z \gtrsim 106$), with two wide regions of instability separating the last three groups. The relative abundances of these groups were calculated as a function of the cosmic-ray leakage time, τ_{CR}, assuming either a constant interstellar density or a constant mean path length (g cm^{-2}). It was found that the ratio of the actinide to Pb group provides the maximum sensitivity for determining the leakage time for this charge region. A comparison with recent experimental measurements indicated that the assumption of an r-process source is justified for this region and yields a mean leakage time consistent with that obtained by other methods for other charge regions. Current observations yield to within an order of magnitude $\tau_{CR} \sim 3 \times 10^6$ years for this charge region. The predicted relative abundance of the SH group depends on nuclear parameters; thus the measurement of SH elements in the cosmic rays could reveal certain properties of these elements. (auth)

936 HIGH ENERGY MUONS (≥150 GeV) IN EXTENSIVE AIR SHOWERS. Saxena, Y. C. (Physical Research Lab., Ahmedabad, India). J. Phys., A (London); 5: No. 10, 1502-13 (Oct 1972).

Results of an investigation on muons of energy ≥150 GeV associated with extensive air showers are presented. The total number of muons is found to vary with shower size according to the relation $n_\mu\ (\geq 150, N) = (27 \pm 7)\ (N/10^5)^{0.47\ 0.05}$ for $10^5 \leq N \leq 5 \times 10^6$. An increase in the power index $\alpha = \partial \ln n_\mu / \partial \ln N$ is indicated for $N < 10^5$. The energy spectrum of the muons is found to be a power law of the type $E^{-1.30 \pm 0.16}$ for 150 GeV ≤ $E_\mu \leq$ 640 GeV. The observed variation of n_μ with N is found to be flatter than the one predicted by known EAS models for constant primary composition. A primary composition varying with primary energy and/or an energy dependent change in characteristics of nuclear interaction at high energies is suggested to account for the observed results. (auth)

937 SWEDISH CONTRIBUTIONS TO THE RECORDINGS OF COSMIC RADIATION 1926–1971. Sandstroem, A. E. (Univ. of Uppsala). Sv. Naturvetensk.; 25: 201-14(1972). (In Swedish).

A short history is given of the recording of cosmic-ray intensity variations by Swedish scientists between 1926 and 1970. Starting with the first experiments, carried out by Ferdinand Lindholm in 1926, a summary is given of the studies by H. Alfvén and K. G. Malmfors during the thirties and forties. The background is given for the organization of permanent Swedish recording stations as part of a world-wide network during the International Geophysical Year and the following International Cooperation for studies of the cosmic-ray intensity time variations. Some experiments of a less permanent character, as studies of the latitude effects, intercalibration of monitors, an experiment for determination of the normal mean direction of the cosmic-ray anisotropy and studies of the charge spectrum, are also mentioned. The later sections deal with the development of the Swedish recording stations and their instrumentation during the last few years. (auth) (Sweden)

938 POSSIBILITY OF A CONSISTENT EXPLANATION OF VARIOUS PHENOMENA INVOLVING COSMIC RAY MUONS. Wdowczyk, J.; Zujewska, E. (Inst. of Nuclear Research, Lodz, Poland). J. Phys. A (London); 5: No. 10, 1514-23(Oct 1972).

A discussion is given of various cosmic-ray phenomena from the point of view of the hypothesis of "regenerated showers." It is shown that the hypothesis, which was originally developed in order to explain muon-poor showers, gives a consistent explanation of various "unusual" phenomena observed in cosmic rays. The most interesting result is that the hypothesis can explain the apparent discrepancy between the high-energy "muon"

spectrum derived from the burst size spectrum and that deduced from other types of observation. With the additional assumption that the passive particle decays into a muon pair with lifetime of the order of 10^{-7}s, the hypothesis can also explain the abnormal angular distribution of energetic muons observed by the Utah group. Some other phenomena which can be explained are indicated and suggestions for further experimental tests of the hypothesis are made. (auth)

939 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16–25, 1971. VOLUME 2. Hobart, Australia; International Union of Pure and Applied Physics (1971). 411p. (CONF-710807–(Vol.2)).

Thirty five papers deal with energetic solar particles and photons including radio and magnetic field effects. Of these, 19 papers are in abstract form only. The remaining 16 are given separate abstracts. Ninety one papers deal with solar modulation and geophysical effects on cosmic radiation. Forty four of these are given separate abstracts, the remainder existing only in abstract form. (Australia)

For abstracts of individual papers see: 940–979, 1036, 1099–1116, and 1169.

940 ELECTRONS IN QUIET-TIME INCREASES, SAMPLERS OF CONDITIONS IN THE OUTER SOLAR SYSTEM. Fisk, L. A.; Van Hollebeke, M. (Goddard Space Flight Center, Greenbelt, Md.). pp 542–7 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

An explanation for quiet-time electron increases is proposed which predicts the existence of a modulating region for cosmic-ray particles lying at ~30 AU from the Sun. (auth)

941 MEASUREMENTS OF THE PRIMARY COSMIC RAY ELECTRON SPECTRUM BETWEEN 20 MeV AND 20 GeV AND ITS CHANGES WITH TIME. Meyer, Peter (Univ. of Chicago); Schmidt, P. J.; L'Heureux, Jacques. pp 548–53 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

Absorption spectrometers on the OGO-5 satellite and high altitude balloons were used to measure the energy spectrum of cosmic-ray electrons in the range from 20 MeV to 20 GeV. The OGO-5 instrument has been in an eccentric orbit since March 1968 and the balloon flights were made from Ft. Churchill, Manitoba in the summers of 1968, 1969, and 1970. Primary electron spectra for the three years were obtained. Changes in these spectra permit a study of solar modulation of electrons over this time interval. A relatively strong modulation was observed in the 500 MeV to 2 GeV energy interval between the summers of 1969 and 1970, a period for which neutron monitor data showed a small modulation of the opposite sign. The force field approximation to the cosmic-ray transport equations was used to infer the rigidity dependence of the diffusion coefficient of electrons in those years. (auth)

942 LOW ENERGY COSMIC RAY PROTONS, He, AND NEUTRAL PARTICLES OVER SYOWA STATION, ANTARCTICA. Tamai, E. (Nihon Univ., Chiba, Japan); Sakai, T.; Narita, N.; (and others). pp 555–60 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

Two de/dX scintillation counters were designed to detect galactic and solar protons, ^{4}He, ^{3}He, and gamma rays, and were flown on Jan. 23 and Feb. 15, 1970, over Syowa Station (69°S, 39.3°E), Antarctica. The data of two flights were obtained in the atmospheric depth of about 11g/cm^2 for 12 hours and 22.5 hours, respectively. Galactic cosmic-ray spectra of protons and helium nuclei in energy region around 100 MeV, quiet days, are reported. Furthermore, an upper limit of gamma-ray flux is estimated at balloon altitudes over Syowa Station. (auth)

943 SOLAR MODULATION OF COSMIC RAY HEAVY NUCLEI (Z = 10 TO 28). Bhatia, V. S. (Panjab Univ., Chandigarh, India); Biswas, S.; Cohan, V. S.; (and others). pp 563–7 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The intensities and differential energy spectra of heavy nuclei (Z = 10 to 28) in the primary cosmic rays were measured in the energy interval 250 to 1000 MeV/N in three balloon flights from Ft. Churchill in 1963, 1964, and 1967 using three emulsion stacks. The relative modulation of heavy nuclei between 1963–1964 and 1964–1967 was studied and these could be represented by the modulation parameter $\Delta\eta$ as 0.54 ± 0.19 and 1.27 ± 0.33 GV, respectively. Using the heavy-nuclei data of 1957 by Aizu et al., the relative modulation parameter of heavy nuclei during 1957–1964 was derived as $\Delta\eta$ = 1.77 ± 0.37 GV. On comparing with the helium nuclei data, it was found that both components were modulated in roughly similar manner in 1963–1967. (auth)

944 EFFECTS OF THE INTERSTELLAR PARTICLES UPON THE INTERACTION OF COSMIC RAYS WITH THE INTERPLANETARY MAGNETIC FIELD. Winter, E. M.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). pp 568–73 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

The flow of interstellar neutral particles into the interplanetary medium has been established observationally. It is suggested that the ionization of these particles will result in an unwinding of the spiral magnetic field. This effect, caused by a transfer of angular momentum from the solar-wind electromagnetic field to these newly ionized particles, is evaluated for cases in which the interstellar gas density is less than or equal to one atom cm^{-3}. It is suggested that this unwinding can account for the boundary effect at 3 to 5 AU indicated by cosmic-ray modulation even if the termination of the solar wind occurs at distances greater than 60 AU. (auth)

945 HELIOCENTRIC RADIAL GRADIENT IN COSMIC-RAY DENSITY MEASURED WITH THE LOST CITY METEORITE. Forman, Miriam A. (State Univ. of New York, Stony Brook); Stoenner, R. W.; Davis, Raymond Jr. pp 575–8 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

The ratio of activities of the argon isotopes ^{39}Ar/^{37}Ar was 2.5 ± 0.25 in the nickel–iron fraction of the meteorite which fell in Lost City, USA on January 3, 1970. The trial of this meteorite was photographed and its orbit determined to have aphelion 2.3 AU, and average distance from the Sun 1.8 AU. From the orbit, and from experimental cross sections for the production of these isotopes in iron, a heliocentric radial gradient of 60 ± 25%/AU was determined for >400 MeV/N cosmic rays. The argon ratio was also consistent with a radial variation in density of the form $n \propto \exp[-(1.25 \pm 0.25)\, r/R\beta]$ where r is in AU and $R\beta$ is rigidity times velocity in GeV. (auth)

946 RADIAL GRADIENTS AND ANISOTROPIES OF GALACTIC COSMIC-RAYS. Urch, I. H.; Gleeson, L. J. (Monash Univ., Clayton, Australia). pp 580–5 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

Extensive numerical calculations were made of the radial gradients and anisotropy vector produced by galactic cosmic-rays penetrating into the solar cavity. They provide estimates of the expected magnitudes of these quantities. The model includes the spiral interplanetary magnetic field, anisotropic diffusion, convection and energy loss processes, and the effects of the interplanetary electric field. Results were obtained for regions near the solar ecliptic plane. Particular attention was paid to protons and helium nuclei with kinetic energies less than 200 MeV/N. (auth)

947 ANISOTROPIES RELATED TO COSMIC RAY DENSITY GRADIENTS. Swinson, Derek B. (Univ. of New Mexico, Albuquerque). pp 588–93 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.2).

Cosmic-ray anisotropies (a) perpendicular to the ecliptic plane, and (b) in the ecliptic plane, can be produced by cosmic-ray density gradients (a) radially outward from the Sun, and (b) perpendicular to the ecliptic plane, respectively, in the presence of the interplanetary magnetic field. Data from underground μ-meson telescopes are presented, analyzed as a function of the direction of the interplanetary magnetic field, showing evidence for both these types of anisotropy. A comparison of the two observed anisotropies gives an estimate of the relative magnitudes of the radial heliocentric cosmic-ray density gradient and the density gradient perpendicular to the ecliptic plane. (auth)

948 COSMIC RAY DENSITY GRADIENT PERPENDICULAR TO THE ECLIPTIC PLANE. Hashim, A.; Bercovitch, M. (Na-

tional Research Council, Ottawa). pp 596-601 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The $B \times \nabla n$ streaming due to a cosmic-ray density gradient perpendicular to the ecliptic plane introduces a component into the diurnal variation that depends on the sense and direction of the interplanetary magnetic field (ipmf). This effect was studied in the diurnal variation data for 1967 and 1968 from a variety of cosmic-ray monitors. The results are consistent with a north–south gradient anisotropy expressed by a power law $\delta I/I = 0.0275R^{0.4} \cos \lambda$ up to an upper limiting rigidity of ~100 GV. These results imply a north–south gradient of $5.5R^{-0.6}\%/AU$; with lower density north of the ecliptic plane than south. This yields a mean effective gradient of ~1.3%/AU for a high-latitude neutron monitor; ~3 to 5 times lower than has been estimated from annual wave measurements. (auth)

949 CHANGES IN THE DIURNAL ANISOTROPY RESULTING FROM A GRADIENT IN THE COSMIC RAY INTENSITY PERPENDICULAR TO THE ECLIPTIC PLANE. Hatton, C. J.; Barker, M. C. (Leeds Univ., Eng.). pp 603-8 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A gradient in the cosmic-ray intensity perpendicular to the ecliptic plane results in a streaming of the cosmic rays within the ecliptic plane which reverses direction with the sector structure of the interplanetary magnetic field. It is found that in 1965–1966 the observed changes in the amplitude and direction of the diurnal anisotropy with sector structure are consistent with the southerly directed perpendicular gradient ~7%/AU observed during those years. (auth)

950 RIGIDITY SPECTRUM OF THE COSMIC RAY SOLAR DIURNAL VARIATION. Humble, J. E. (Univ. of Tasmania, Australia). pp 612-17 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Comparison of neutron monitor and underground muon telescope observations of the steady-state solar diurnal variation between 1961 and 1966 suggests that, in the range above 2 GV, the most probable value of the variation's rigidity exponent, β, is slightly positive, on average about +0.2. The currently accepted zero value of β cannot, however, be excluded in four of the six years. The upper limiting rigidity R_u is found to vary in the range 50 to 100 GV. The suggestion of nonzero β arises from simultaneous consideration of β and of R_u. Due to the latter's relatively low value it is not entirely valid to consider these quantities as independent variables. It is necessary to take account of both amplitude and phase information from all detectors. Re-estimation of statistical errors involved suggests that the limits of determination of β and R_u are wider than has previously been believed. (auth)

951 SPECTRAL CHARACTERISTICS OF DIFFERENT TYPES OF DIURNAL VARIATION OF COSMIC RAYS. Kane, R. P. (Physical Research Lab., Ahmedabad, India). pp 618-22 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Diurnal variation of cosmic rays has a large day-to-day variability. For several days at a time, it is either negligibly small or of moderate or very large amplitudes. The hour of maximum also shows similar variability. Assuming that different hours of maxima (ϕ) represent different types of diurnal variation sources, days in 1965–1968 are divided into 8 groups of 3-hourly ϕ intervals. Spectra of the type E^{-m} are fitted. It is shown that m values differ from group to group. (auth)

952 EFFECTS OF LONG LIVED SOLAR CENTRES ON THE GALACTIC COSMIC RAY INTENSITY. Antonucci, E.; Castagnolli, G. Cini; Dodero, M. A. (Univ., Turin). pp 623-8 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The analysis of cosmic-ray intensity data registered at sea level, and of solar activity data during the periods October 1967–April 1968 and February 1969–January 1970, has led to the conclusion that central meridian passages of long-lived flare-producing regions are connected to cosmic-ray intensity decreases. The latitudes and the Carrington longitudes of the centers of the regions producing flares with importance ≥1 B (during the year 1969, solar rotations 1854–1867) were mapped. Two particularly active zones produced some 80% of the flares observed during the year. Daily means from the Deep River neutron monitor station are shown together with the number of flares produced by each region belonging to the two zones at the date of central meridian passage of the region. The twelve passages at CM of zone I produced twelve important decreases in the cosmic-ray intensity which constitutes a series of recurrent events. Concerning zone II only the first five rotations give recurrent decreases. In some cases it seems possible to identify also a particular flare belonging to the region at CM which could have started the event. However, in seven cases the selected regions are not noticeably active in front of the Earth. (auth)

953 UNDERGROUND COSMIC RAY INTENSITY MODULATION AND INTERPLANETARY STRUCTURES DURING 1969 TO 1970. Antonucci, E.; Castagnoli, G. Cini; Dodero, M. A. (Univ., Turin). pp 629-34 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

In order to compare sea level and underground cosmic-ray intensity modulations during the passages at CM of the two active solar zones identified in the preceding paper, the data registered in the Monte dei Cappuccini Station at 70 m.w.e. was plotted, together with the Deep River daily means and the CMP's of flare-producing regions between September 1969 and May 1970. The data registered by one section of 2 m^2, and the total counting rate of 5 m^2 of scintillators, respectively, were plotted. As for the sea-level cosmic ray intensity, typical decreases of the energetic galactic radiation detected underground were related to the two long-lived solar regions. Trough-shaped depressions of the order of 1%, generally starting a few days before and centered on the CMP's, were observed. No clear connection of solar phenomena with cosmic-ray intensity could be established from the data during the first months of the year 1970, when the solar activity spreads over a wide range of solar longitudes. (auth)

954 UNDERGROUND COSMIC RAY OBSERVATIONS AT AN EQUATORIAL STATION. Thomson, D. M.; Sumner, D. J. (Makerere Univ., Kampala, Uganda). pp 635-40 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Semi-cubical cosmic-ray meson telescopes inclined at 45°E & W have been operated at a mean depth of 40 mwe at Kilembe Mines, West Uganda, from May 1970. The solar time diurnal variation averaged over a complete year is reasonably consistent with a flat spectrum primary modulation of 0.4% in the 1800 hr direction when the effect of the Earth's orbital motion is taken into account. The upper rigidity limit is 90 ± 20 GV and may currently be declining. The semidiurnal solar time variation shows that the upper rigidity limit of this modulation does not greatly exceed 100 GV. There appears to be a genuine sidereal time variation of 0.03 ± 0.015% with a maximum near R.A. 6 hrs. The effective viewing direction of the telescopes is 16°N of the equatorial plane. (auth)

955 SECULAR VARIATION OF THE LIMITING PRIMARY REGIDITY OF THE SOLAR DIURNAL ANISOTROPY OF COSMIC RAYS. Ahluwalia, H. S. (Univ. of New Mexico, Albuquerque). pp 641-5 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

At the eleventh international conference on cosmic rays, Ahluwalia and Ericksen reported that the upper cut-off rigidity (R_c) applicable to the solar diurnal variation of cosmic rays shows a positive correlation with solar activily. At that time it was not clear what index of solar activity relates best with R_c. This analysis was continued with additional data from the University of New Mexico network of underground telescopes. It appears that R_c correlates better with the intensity of the coronal green line (5303 Å), over the range of heliolatitudes of ±5° with respect to the solar equator, than with sunspot numbers. The analysis indicates that the coronal green line intensity is perhaps a consistent measure of the effect of the solar modulation on cosmic rays. (auth)

956 COMPARISON OF LONG-TERM VARIATION OF DIURNAL ANISOTROPY OBSERVED BETWEEN MESON AND NEUTRON MONITORS DURING THE PERIOD 1965 TO 1969.

Agrawal, S. P.; Ananth, A. G.; Rao, U. R. (Physical Research Lab., Ahmedabad, India). pp 646-50 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

It is well known that any comparison of diurnal anisotropy observed between meson and neutron monitors requires the application of an adequate temperature correction of meson monitor data. Attempts by Carmichael, Bercovitch, and others have shown that inspite of the nonavailability of radiosonde data, one can, in principle, correct for the meson intensity by knowing the ground temperature variations. To resolve the apparent discrepancies between the results obtained from meson and neutron monitors, particularly with regard to the long-term change in diurnal vector, the question of temperature correction of meson data has been reexamined. New temperature correction factors have been obtained for 1965–1969 which are consistent with what should be theoretically expected from the known temperature variations in the atmosphere and seem to yield results consistent with those obtained from neutron monitors. The temperature corrected meson data has been used to investigate the year to year variation of diurnal vector and the variation of upper cut off rigidity with solar cycle. (auth)

957 DIURNAL VARIATION OF COSMIC RADIATION IN THE ENERGY RANGE 1 TO 100 GeV ON DAY-TO-DAY BASIS. Ananth, A. G.; Agrawal, S. P.; Rao, U. R. (Physical Research Lab., Ahmedabad, India). pp 651-6 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Even though the average cosmic-ray daily variation is consistent with the theoretical picture of partial corotation of cosmic-ray particles, the diurnal variation on day-to-day basis shows a great variability both in the amplitude and in the time of maximum. Both days having abnormally large amplitudes and days having negligible amplitudes seem to occur in trains. The enhanced diurnal variation is shown to be due to either the existence of sink in the garden hose direction, or due to an excess flux from the anti-garden hose direction. Trains of days having negligible diurnal variation are often found to be due to an excess flux along the garden hose direction. The physical implications of both types of diurnal variation are examined. (auth)

958 DIURNAL ANISOTROPY AND EAST-WEST ASYMMETRY VARIATIONS. Webb, G. (Univ. of Tasmania, Australia). pp 657-60 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Observations with east and west pointing muon telescopes at Mawson and Hobart during a full solar cycle show: (1) a seasonal variation in the east–west asymmetry, of amplitude 0.01 to 0.16% due to extra-atmospheric effects. (2) A variation in the annual mean asymmetry which is significantly anticorrelated with smoothed Zurich sunspot number, except in 1958 when the asymmetry was considerably larger than expected. An explanation of the seasonal variation is given in terms of cosmic-ray streaming. The diurnal anisotropy measured by a directional telescope on the rotating Earth is obtained. Variations in the secondary muon spectrum in Fenton's (1952) modification of Johnson's (1941) theory of the east–west asymmetry could explain the solar cycle variation of the asymmetry. (auth)

959 COSMIC RAY ANISOTROPY IN INTERPLANETARY SPACE. I. ORIGIN OF SOLAR SEMI-DIURNAL VARIATION. Nagashima, K.; Fujimoto, K.; Fujii, Z.; Ueno, H.; Kondo, I. (Nagoya Univ., Japan). pp 661-5 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Origin of the solar semi-diurnal variation of cosmic-ray intensity was studied using mainly data observed by a multi-directional meson telescope at Mt. Norikura for the period 1968–1970. Two possible mechanisms producing this variation, the density gradient and the pitch angle distribution were examined in the light of the annual variation of a special diurnal variation arising from the second spherical harmonic anisotropy in space. The annual variation of this special diurnal variation which corresponds to a spacial cosmic-ray distribution of $P_2^1(\cos\theta)$-type was derived from 2nd order differences among data for cosmic rays arriving from several directions at Mt. Nodikura. It is found that the origin of the second spherical harmonic anisotropy producing the observed semi-diurnal variations is the pitch angle distribution of cosmic-ray intensity relative to the interplanetary magnetic field. (auth)

960 COSMIC RAY ANISOTROPY IN INTERPLANETARY SPACE. II. LOSS CONE MODEL. Fujii, Z.; Nagashima, K.; Fujimoto, K.; Ueno, H.; Kondo, I. (Nagoya Univ., Japan). pp 666-71 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The mechanism producing the pitch-angle distribution of cosmic-ray particles in interplanetary space described in Part I was studied. The pitch-angle distribution of cosmic-ray particles about the interplanetary magnetic field was calculated under following assumptions: (1) Cosmic-ray particles moving along the interplanetary magnetic field lines will return to the Earth after they reach mirror points inside the Earth's orbit if they do not experience scattering process. (2) Particles are scattered by a distance comparable to the gyration radius through interaction with the irregularities in the magnetic field. (3) Cosmic-ray density has a negative gradient in the direction normal to the ecliptic plane, i.e., it has a maximum at the ecliptic plane. A loss cone is produced in the pitch-angle distribution by exchange of particles due to the scattering process. Second harmonic component of the cosmic-ray anisotropy reported in I is reasonably explained if the half opening angle of the loss cone is less than 90°. Furthermore, it is found that other harmonic components, 1st, 3rd, 4th, etc., should be observed in the cosmic-ray anisotropy. (auth)

961 DAILY-VARIATION THIRD HARMONIC OF THE COSMIC RADIATION. Mori, S.; Yasue, S.; Ichinose, M. (Shinshu Univ., Matsumoto, Japan). pp 673-8 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

By performing harmonic analysis, and also power spectrum analysis of neutron monitor data at Deep River for the period 1962–1969, the consistent daily-variation third harmonic in cosmic-ray intensity was derived. The averaged amplitude was 0.013% and the phase 6.3 hr (L.T.) over these time intervals, and was also found that the observations were free from the contamination of atmospheric pressures. Yearly averaged characteristics of the anisotropy, obtained by the worldwide neutron monitor data would be: of similar spectrum to the semi-diurnal anisotropy having its peak amplitude at about 50 GV, and in the direction of around 1 hr, 9 hr, and 17 hr (L.T.) in space. (auth)

962 SPECTRA OF PRIMARY COSMIC RAYS DURING DAYS OF ENHANCED DAILY VARIATIONS. Kudo, Shoko; Wada, Masami (Inst. of Physical and Chemical Research, Tokyo). pp 679-84 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Using world-wide neutron monitor data, 1966–1968, the second and third harmonics of the daily variation were investigated. The samples were picked up from days when the amplitudes were significantly enhanced. In order to reject any ambiguity in analysis, days when the variation in the isotropic component exceeded the daily variation were not included in the data. (auth)

963 VARIABILITY OF THE COSMIC RAY STREAMING STUDIED BY POWER SPECTRUM TECHNIQUE. Lindgren, S. T.; Martinic, N. J.; Tolba, M. F. (Univ. of Uppsala). pp 685-9 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The stability of existing cosmic-ray anisotropies has been studied in 1965–1967. Periodicities in the axial anisotropy appear only with short duration and therefore tend to disappear in statistical averages over long times. 7 to 14 day periods have however been found in samples covering 6 to 7 solar rotations each. The Deep River hourly rate shows a solar cycle variation in the power at frequencies between 0.01 and 0.5 c/day. The variation amounts to one order of magnitude with minimum power in 1964 and 1965. The power of the amplitude of the diurnal wave shows several peaks corresponding to periods of 4 to 14 days, the characteristic length of enhanced wave trains. (auth)

964 LARGE AMPLITUDE DIURNAL WAVE TRAINS: 1966 TO 1968. Tolba, M. F.; Lindgren, S. T. (Univ. of Uppsala).

pp 690-5 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The relation between phase and amplitude was studied in five trains of large amplitude diurnal waves which occurred in 1966-1968 during periods free of Forbush decreases and pronounced geomagnetic disturbances. Large amplitudes were associated with maxima after 18 hours AT (asymptotic time), small amplitudes with early maxima. This relation can be explained in terms of two components of streaming: a constant azimuthal streaming and a varying streaming in the average direction of the interplanetary magnetic field. The amplitude of the azimuthal component is found to be 0.6% for the long trains. (auth)

965 ANOMALOUS DIURNAL VARIATION OF COSMIC RAYS WITH MAXIMUM ALONG THE GARDEN HOSE DIRECTION. Razdan, H.; Bemalkhedkar, M. M. (Physical Research Lab., Ahmedabad, India). pp 697-702 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The average diurnal variation of galactic cosmic rays is known to exhibit an amplitude of 0.4% along the 18 hr direction in the interplanetary space. The characteristics on individual days, however, depart from the average both in terms of the amplitude and the phase. The exact picture of the electromagnetic conditions in interplanetary space which lead to such departures from the average behavior is not yet clear. Another class of enhanced diurnal variation in cosmic ray intensity is presented which shows a maximum along the garden hose direction in interplanetary space and occurs in groups of 3 to 5 days during the recovery of a Forbush or a gradual commencement type decrease. These decreases are found to be associated with either an east limb flare or a solar M region stream. (auth)

966 TWO CLASSES OF FORBUSH DECREASES. Verschell, Howard J.; Mendell, Rosalind B.; Korff, Serge A. (New York Univ., N. Y.). pp 705-10 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Comparison of simultaneous observations of the fast neutron flux in the upper atmosphere (mean energy of response to primary radiation, 1 to 2 GeV/N) and high-latitude neutron monitors (mean response 10 to 15 GeV/N) has resulted in the identification of two classes of Forbush decrease. Class I consists of large rapid Forbush decreases (≥5% in the neutron monitor counting rates) following solar flares, and is characterized by a slower recovery of the lower energy fluxes relative to the higher energy fluxes than would be expected from the 1968 regression curve of the two detectors. Class II Forbush decreases are not associated with solar flares. They tend to be smaller in amplitude and to take longer to decline to minimum. Both the decline and the recovery rates are steeper than those observed for the Type I decrease. It is suggested that Class I and Class II decreases are essentially the same, both being quasi-stationary corotating structures and differing only in their stages of evolution. Class I decreases are formed during the rotation in which they are observed. Class II decreases are often "older" by at least one solar rotation. Hence the modulating region is in quasi-equilibrium, so that the time rate of change of the depression represents the azimuthal spatial gradient of the cosmic-ray flux. (auth)

967 SOME PROPERTIES OF MEAN MULTIPLICITY MEASURED IN THE NM64 NEUTRON MONITOR. Kodama, Masahiro (Inst. of Physical and Chemical Research, Tokyo). pp 711-16 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The time variation of the mean multiplicity in the 12-NM64 neutron monitor was investigated using the data from Syowa Station in Antarctica, when energetic solar-flare particles were observed at ground level. For three events of small solar cosmic-ray increases since 1969, the mean multiplicity produced by solar particles alone was found to be 0.109 to 0.155 below relative to that for galactic cosmic rays. This also gave the significant decrement of from 0.008 to 0.019 into the observed mean multiplicity. It is shown that the reasonable power law exponents for energy spectra of solar particles could be deduced from the observation values of these mean multiplicities using the specific yield functions for different multiple events. (auth)

968 TRANSIENT NORTH-SOUTH ANISOTROPIES IN THE COSMIC RAY INTENSITY. Mercer, J. B.; Barker, D. N. H.; Griffiths, W. K.; Hatton, C. J. (Univ. of Leeds, Eng.). pp 717-22 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Using data from four polar neutron monitors, a search was made for north-south anisotropies in the cosmic radiation during the period August 1966 to November 1967 (solar rotations 1820-1837). It was found that: (a) N-S anisotropies are a common feature of the cosmic radiation, occurring on >43% of all days, (b) all Forbush decreases are accompanied by such anisotropies in the onset phase, and (c) a significant proportion of days outside Forbush decreases (~35% of the days analyzed) exhibit N-S anisotropies. The existence of anisotropies with large N-S components is discussed in relation to the study of anisotropies in the ecliptic plane. (auth)

969 COSMIC RAY ANISOTROPIES PERPENDICULAR TO THE EQUATORIAL PLANE. Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). pp 723-8 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A systematic search for events characterized by transient north-south asymmetry in the cosmic-ray intensity during Forbush decreases and cosmic-ray storms was conducted. Nucleonic intensity data recorded during the period January, 1967 to March, 1971 at a number of suitably located stations were analyzed for this purpose. Comparison of these results with those of a similar analysis covering the period from 1964 to 1966 revealed that detectable axial anisotropy is much more prevalent during the epoch of greater solar activity. The study also showed that north-south asymmetry may occur during any phase of a cosmic-ray storm. Two remarkable new types of event were observed: (a) long duration and (b) phase inversion. (auth)

970 MECHANISM FOR THE FORBUSH DECREASE, IN PARTICULAR FOR THE EVENT OF FEBRUARY 26, 1969. Quenby, J. J. (Imperial Coll. of Science and Tech., London). pp 730-5 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Cosmic ray and interplanetary magnetic field data obtained during the Forbush Decrease of February 26, 1969 is discussed in relation to three models. These are: a perturbation to the long-term mechanism, the Parker shock wave model, and a barrier mechanism involving a large-scale tangential discontinuity. Only the third model seems to provide a generally adequate effect. The problem of enhanced anisotropies at the time of a Forbush decrease is also considered in terms of local gradients and the sweeping out of particles by the shock. (auth)

971 COSMIC RAY INTENSITY LARGE-PERIOD MODULATION DURING 1961 TO 1970. Martinic, N. J. (Univ. of Uppsala). pp 745-51 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The spectra of periodicities of cosmic-ray intensity measured by Deep River neutron monitors show recurrences at ~50 days, ~90 days, and ~200 days compatible with the 0.9 probability which defines the confidence band of the power spectra densities during 1961-1970. The annual wave calculated by harmonic analysis gives a mean wave of (0.5 ± 0.3) % which is consistent with the amplitudes calculated from the power spectrum of (0.8, +0.2, and -0.3) % for approximation defined by the confidence interval. The phase of the annual wave is defined by a maximum intensity centered around December. (auth)

972 OBSERVATIONS OF THE COSMIC RAY MODULATION FROM NEUTRON MEASUREMENTS AT THE HIGH LATITUDE TRANSITION MAXIMUM. Verschell, Howard J.; Mendell, Rosalind B.; Korff, Serge A. (New York Univ., N. Y.). pp 752-7 of 12th International Conference on Cosmic Rays, Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A measurement of secondary neutrons was used to examine some features of galactic cosmic-ray modulation. The fast neutron spectrometer, flying in aircraft since January, 1968,

made frequent measurements at the transition maximum. The mean energy of response to the galactic primary spectrum was 1 to 2 GeV/N as compared with the mean response of 10 GeV for the Inuvik neutron monitor over which the detector flew. The regression relation between the two components of the primary radiation was observed to change, especially during cosmic-ray minimum. The implications of these complications are discussed. (auth)

973 SOLAR CYCLE VARIATIONS IN THE POLAR ATMOSPHERIC NEUTRON FLUX AT BALLOON ALTITUDES. Greenhill, J. G.; Fenton, A. G.; Fenton, K. B. (Univ. of Tasmania, Australia). pp 758-63 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The atmospheric neutron flux over Wilkes, Antarctica (66.4°S, 110.5°E), was monitored during much of the present solar cycle using specially calibrated balloon-borne BF_3 neutron detectors. During geophysically quiet periods the flux at all levels correlated well with the sea-level neutron monitor rate. At an atmospheric pressure-altitude of 25 millibars, the neutron flux decreased by a factor of 2.0 between May 1965 and November 1968, i.e. from solar minimum to solar maximum. During this period the absorption length increased by about 10%. The calculated value of the absolute neutron flux at 80 millibars during May 1965 was 6.2 ± 1.6 cm^{-2} sec^{-1}. (auth)

974 IMPLICATIONS OF A LONG-LIVED RECOVERY OF COSMIC RAY INTENSITY. Roelof, Edmond C. (Univ. of New Hampshire, Durham); Verschell, Howard J.; Mendell, Rosalind B. pp 764-70 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The unusually long-lived recovery of depressed cosmic-ray intensity beginning at a minimum in late June 1969 and steadily increasing until the Forbush decrease of September 27, 1969 was studied. Of particular interest was the weak energy dependence of the recovery. The ratio of the NYU airborne neutron detector (mean response 1 to 2 GeV/N) to the Inuvik sea level neutron monitor (mean response 10 to 15 GeV/N) was constant to within ±1.5% during this period while the sea-level flux increased by 5%. It is shown that a simple (but not necessarily unique) implication of the data is that the mean-free-path for scattering of galactic cosmic rays was p-independent follows if the spatial power spectrum of the irregularities in the interplanetary magnetic field (averaged over the modulating region) was proportional to the square of the wave length as spectral studies of the long-term variation indicated. (auth)

975 INTERPLANETARY MAGNETIC FIELD FLUCTUATION MEASUREMENTS AND THE LONG TERM MODULATION. Quenby, J. J.; Sear, J. F. (Imperial Coll. of Science and Tech., London). pp 771-6 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Experimental measurements of the power spectra of interplanetary field fluctuations are compared with solar-cycle modulation observations. It is found that a particle diffusion coefficient going as r^{+1} or r^{+2} out to a boundary at ~10 AU best fits the results, with an exponential modulation factor ≤1. Solar cycle modulation arises primarily through mean free path variations. Observed changes in the low frequency spectral power could account for the variations seen in the upper limit to the diurnal wave. (auth)

976 COMMENTS ON THE ABSOLUTE IONIZATION OF COSMIC RADIATION AT BALLOON ALTITUDES COVERING FOUR SOLAR MAXIMA. Carmichael, Hugh (Atomic Energy of Canada, Ltd., Deep River, Ont.). pp 779-84 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Measurements of the absolute value of the ionization of cosmic radiation in the upper atmosphere made by Millikan and Neher and then by Neher since 1937 have been interpreted by Neher to indicate a general decline of intensity between the 1937-38 period and the period from 1950 to the present time for the same level of solar activity. In order to assess the probable validity of this result, the implications of which are far reaching, simultaneous absolute determinations made at various times since 1937 by three other laboratories are summarized and critically compared with the measurements by Neher. (auth)

977 SOURCE SPECTRUM OF COSMIC RAY NUCLEI, AND THE SPECTRA OF PROTON AND HELIUM NUCLEI NEAR THE EARTH. Ramadurai, S.; Biswas, S. (Tata Inst. of Fundamental Research, Bombay). pp 793-8 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

It is shown that the rate of energy gain from the Fermi theory of acceleration contains a velocity term which is to be taken into account in case of nonrelativistic particles. A spectral form is derived on this basis which is called "Fermi Spectrum". This spectrum is the correct form of the accelerated particles in the entire energy range on the basis of Fermi theory. Assuming (i) the source spectrum as Fermi spectrum, and (ii) the diffusion–convection model of solar modulation, it is found that both protons and helium nuclei spectra measured near the Earth can be explained. The residual solar modulation parameter is found to be 0.25 GV and 0.45 GV in 1965 and 1968, respectively. (auth)

978 FOKKER–PLANCK EQUATION WITH CONVECTION AND NONSYMMETRICAL SCATTERING OF COSMIC RAYS PARTICLES. Zacharchenko, V. F. pp 800-1 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The transport equation for cosmic rays in the interplanetary medium is derived by using the Fokker–Planck approximation for the description of particle scattering and convection in impulses space. The regular magnetic field and convection velocity directions are arbitrary. (auth)

979 ENERGY SPECTRUM AND ANGULAR DISTRIBUTION OF ATMOSPHERIC ALBEDO NEUTRONS. Reppin, C.; Schoenfelder, V.; Kanbach, G.; Pinkau, K. (Max-Planck Institut fuer Physik und Astrophysik, Garching, Ger.). pp 834-9 of 12th International Conference on Cosmic Rays, Vol. 2, Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

First results of an accelerator calibration of an experiment to measure atmospheric albedo neutrons are presented. These results confirm the efficiency obtained by former Monte Carlo calculations. This means that the neutron albedo spectrum seems to be indeed larger than theoretical estimates by about a factor of 3. Furthermore, due to an unexpected second maximum in the angular resolution curve at 90°, the atmospheric neutron angular distribution seems to be more strongly peaked at 90° than was thought hitherto to be the case. (auth)

Stars

Refer also to abstract 1050.

980 PRELIMINARY REPORT ON THE INFRARED SPECTRUM OF NOVA SERPENTIS 1970. Ciatti, Franco; Mammano, Augusto. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 52: No. 1, 62-71(Jan 1972).

The emission lines observed in Nova Serpentis 1970 are listed. In order to get a better insight, an attempt was made to determine relative intensities of the most significant features which are given. The cooling required by the S-1 detector, the long exposure due to its low sensitivity, and difficulties in locating the continuum add more uncertainties to the usual difficulties of the photographic photometry. From the description of the spectral evolution it was inferred that the excitation in the ejected nebula increased till the end of September 1970. After this date a weakening was observed of most HeI and HeII lines. This is confirmed by the fading in 1971 of [FeVII] 8738 and 6085 in comparison with [OI] 6300-6363. The apparent increase of some forbidden lines in comparison with the permitted ones cannot be due to a further increase of excitation, because the I.P. of HeI, SII and ArII are about the same. Since the E.P. of HeI 10830 (1.1 eV) is less or equal to those of forbidden lines, its fading should mean that depopulation of the metastable lower level (E.P. = 19.73 eV), from which this line is excited by collision, occurs at a faster rate than recombination of the ions responsible for the forbidden transitions. (W.D.M.)

981 IONIZATION THEORY AND ASTROPHYSICS. Basu, B. N. (Jadavpur Univ., Calcutta). Sci. Cult. (Calcutta); 38: No. 1, 12-15(Jan 1972).

The significance of Saha's Ionization Theory published in the Philosophical Magazine in 1920 to the field of stellar spectra is discussed. (W.D.M.)

982 NUCLEAR REACTIONS IN STARS. I. Kisdi, David Fiz. Szemle; 22: No. 6, 171-82(Jun 1972). (In Hungarian).

According to currently accepted concepts, the energy released into space by the Sun and other stars in form of thermal radiation is generated by thermonuclear reactions. The contraction of the stellar matter releases large amounts of gravitational energy which however is not sufficient to account for all the emitted energy. Chemically stored energy is also too small and could maintain the luminosity of the Sun at the present level for only 1500 years. Only nuclear reactions can justify the large amounts of energy released for extremely long life times. The reaction cross sections near the resonance peaks are according to the Breit–Wigner formula about 1000 times higher than in the non-resonance regions; in all probability, nuclear reactions of astrophysical interest take place in that range. The theory of thermonuclear reactions is reviewed. The most important reaction during the initial portion of the evolution of stars is the hydrogen burning because most stars created by the condensation of cold stellar matter consist of that element. This series of reactions includes interaction between deuterons and protons, starting at 8000°K and yielding temperatures of about 8 million °K, at which 4 hydrogen nuclei form helium under the release of an energy of Q = 26.730 MeV. The H–He fusion may follow the pp chain process or the CNO cycle. The internal temperature of the Sun is about 15 million °K; about 96% of its energy is generated by the pp chain. (TTT)

983 NUCLEAR REACTIONS IN STARS. II. Kisdi, David. Fiz. Szemle; 22: No. 7, 200-6(Jul 1972). (In Hungarian).

The hydrogen burning takes place slowly, ending when all hydrogen is exhausted. At that time, a ^{4}He containing central nucleus is formed in the star. The renewed contraction increases the temperature and the emitted energy, resulting in the formation of red giants. At temperatures above 10^8°K helium burning is initiated, creating ^{8}Be in the thermodynamic equilibrium $^4He \rightleftharpoons {}^8Be$; the latter reacts with He, according to the reaction $^4He + {}^8Be \rightleftharpoons {}^{12}C^* \rightarrow {}^{12}C + \gamma$. The fusion of the 3 ^{4}He nuclei into ^{12}C yields an energy of 7.275 MeV. During the helium burning, small amounts of intermediate isotopes, ^{16}O, ^{20}Ne, ^{24}Mg, and even ^{28}Si are also formed. This completes the energy generation in small stars which then collapse, cool down creating white dwarfs. The ^{12}C flash process yields γ radiation and p, n, and α emissions. It is followed by either the ^{16}O or the ^{20}Ne flash processes, depending on the physical conditions of the stellar matter. Synthesis of the chemical elements involves 8 processes: H burning, He burning, the α process, the e process, the s process, the r process, the p process, and the x process. These processes, proton capture, slow and rapid neutron capture, etc. chains make it possible to follow up the chemical evolution of galaxies. It is surprising that the relative abundance of the elements in the solar system does not differ markedly from the ratio in the Galaxy; this indicates that within a space with a diameter of several hundreds or thousands of light years the elements were strongly mixed before the evolution of the Sun. (TTT)

984 CONVECTIVE-UNSTABLE LAYER IN A PERIODIC GRAVITATIONAL FIELD. Ivanov, L. N. Vestn. Leningrad. Univ., No. 19, Mat., Mekh., Astron.; No. 4, 125-32(Oct 1971). (In Russian).

The energy transfer process in the convective zone of the close binary star with asynchronous rotation is considered. In the case of plane-parallel liquid layer the oscillations of the convective flux and the temperature are calculated. The equations for the same process in the case of compressible gas are given. (auth)

985 SPECTRAL ANALYSIS OF 53 CAMELOPARDALIS. Kurkowski, Jerome James. Washington, D. C.; Georgetown Univ. (1972). 73p. University Microfilms Order No. 72-23,399.

Thesis.

A coarse analysis using a Wrubel curve of growth for $B_0/B_1 = 2/3$ and $\log(a) = -1.8$ was performed on the star 53 Cam. The plate material used was a 6.5 A/mm plate taken at the Dominion Astrophysical Observatory. Abundances were determined for 13 elements in the star's spectrum. The elements were: Ti, V, Cr, Mn, Fe, Zr, La, Ce, Pr, Nd, Sm, Eu, and Gd. Iron, chromium, vanadium, and zirconium were found to be overabundant. Titanium was found to be about normal or slightly overabundant. Manganese seemed underabundant. The rare earths seemed to be quite overabundant. Some of the results are tentative because of the small number of lines used in the analysis and because of errors in the equivalent widths due to blending. The results were compared with the predictions made in recent theoretical work. The abundances for iron, the rare earths, and possibly chromium seemed to be of the right order of magnitude, as predicted by Peterson (1970), to produce light and color changes in the star. The results were also in qualitative agreement with the theories of Michaud (1970) and Havnes and Conti (1971). Suggestions for future work are made. (Diss. Abstr. Int., B)

986 COLD NEUTRON STAR MODEL IN BRANS–DICKE THEORY OF GRAVITY. Matsuda, Takuya (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 341-3(Jul 1972).

A cold spherical neutron star was investigated in the Brans–Dicke theory of gravitation and the results were compared with general relativity theory. (W.D.M.)

987 PHOTOMETRY OF SUPERNOVA 1972 IN NGC 5253. Lee, T. A. (Univ. of Arizona, Tucson); Wamsteker, W.; Wisniewski, W. Z.; Wdowiak, T. J. Astrophys. J.; 177: No. 2, L59-62(15 Oct 1972).

Results are reported for UBVRIJK photometry of the bright supernova 1972 in galaxy NGC 5253. The observations obtained over a span of 43 days show the UBV measurements to be of similar character as those made on previous supernovae classed as Type I. Infrared observations made at 1.25 and 2.2 microns during two nights separated by 38 days show nearly identical magnitudes. The measurements show the decline in all bands to have definite irregularities. (auth)

988 STABILITY OF STATIC CONFIGURATIONS OPPOSITE ADIABATIC PERTURBATIONS. Scuflaire, R. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 10, 1126-36(1971). (In French).

On the basis of the energy principle it is shown quite generally that Schwarzschild's criterion is a necessary condition of stability. (auth)

989 RECENT CHANGES IN THE NATURE OF V1057 CYGNI. Schwartz, Richard D.; Snow, Theodore P. Jr. (Univ. of Washington, Seattle). Astrophys. J.; 177: No. 2, L85-6(15 Oct 1972).

Photometric and spectroscopic data show that V1057 Cyg, which had a spectrum of an A-type giant or supergiant after its flare-up in late 1969, now has an early F-type spectrum of similar luminosity class. This is consistent with the history of FU Ori, which underwent a similar flare-up in 1936, except that V1057 Cyg now shows no evidence of shell features in its spectrum. (auth)

990 CORE HELIUM BURNING IN MASSIVE STARS. Robertson, J. W. (Australian National Univ., Canberra). Astrophys. J.; 177: No. 2, 473-88(15 Oct 1972).

Nine evolutionary sequences were computed from the initial main sequence well into the core-helium-burning stage, for stellar masses in the range 6 to 20 $M_\odot$ and for a variety of initial chemical compositions. The effects of semiconvection on the distribution of core-helium-burning stars in the H–R diagram were studied for two cases: case A, in which the chemical composition gradient was included, and case B, in which it was neglected, in the criterion for convection. The ratio t_{br} of time spent as a core-helium-burning blue supergiant to time spent as a core-helium-burning red supergiant is shown to depend sensitively on the depth of the convective envelope at the red-giant tip, which in turn depends sensitively on the chemical composition and the envelope opacities. Comparison with the results of Chiosi and Summa showed that the ratio t_{br} increases rapidly with stellar mass, in the range 15 to 20 $M_\odot$, as required by the observations of massive supergiants (Stothers). (auth)

991 EXPLOSIVE NUCLEOSYNTHESIS IN THE OUTER LAYERS OF STARS. Howard, William Michael. Houston, Tex.; Rice Univ. (1972). 168p. University Microfilms Order No. 72-26,422.

Thesis.

The network of nuclear reactions that are expected to occur when the hydrogen and hydrogen-exhausted zones of a star are instantaneously heated and allowed to expand adiabatically, as might occur when a star undergoes a supernova explosion, was studied by numerical integration. The dependence of the results on nuclear cross sections, on the peak temperature, and on the time scale of the hydrodynamic expansion is discussed. From stellar models, the density in the hydrogen-rich envelope of the star appears too low for significant nuclear processing to occur. Of particular interest in the hydrogen-exhausted zone is the result that the nucleus ^{14}N, constituting about two percent by mass following the earlier operation of the CNO cycle, is substantially converted to ^{15}O, ^{18}F, ^{19}Ne, and ^{21}Ne in ratios close to the solar abundances of ^{15}N, ^{18}O, ^{19}F, and ^{21}Ne. These nuclei very likely owe their natural origin to such events. (Diss. Abstr. Int., B)

992 CLASSIFICATION OF INTRINSIC VARIABLE STARS. II. THE RED VARIABLES OF S AND RELATED TYPES. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 177: No. 2, 489-507(15 Oct 1972).

Observations in the (UBVRI) system are presented for 34 stars

of S or related type. Twenty-four of these stars are named variables (first light curves were obtained for two of these, π^1 Gru and Henize 120), suspected variation in three stars (HD 58881 = HV 100, HD 75021, and HD 168227 = HV 170) is confirmed, and five new variables (HD 34738, HD 49368, HD 52432, HD 216672, and Henize 244) were found. Membership in the Wolf 630 group (R And and HR 1556), σ Puppis group (HR 363) and Hyades group (π^1 Gru) is used to demonstrate that the S stars occur on the giant sequence of the old disk population. Several other group members are indicated, but the available proper motions are too uncertain for use in calibrating the luminosities. The available space motions of the S stars are characteristic of the old disk population. (W.D.M.)

993 EFFECTS OF THE SURFACE H/He RATIO ON SPECTRA OF CARBON STARS. Thompson, Rodger I. (Univ. of Arizona, Tucson). Astrophys. J.; 177: No. 2, 509-13(15 Oct 1972).

It is shown that observations of CH in N irregular and semiregular carbon stars are consistent with hydrogen depletion by a factor of 10 as predicted by a CNO bi-cycle model. Chemical abundances for carbon stars at constant temperature and pressures have been calculated for hydrogen mass fractions from 0.739 to 10^{-4}. (auth)

994 REALITY OF A GROUP OF CARBON STARS IN AURIGA. Richer, Harvey B. ((Univ. of Rochester, N. Y.); Sharpless, Stewart; Campbell, Bruce. Astrophys. J.; 177: No. 2, 515-18(15 Oct 1972).

The properties of a group of seven carbon stars whose projected positions make them appear clumped together are examined. It is concluded that the seven do not form a physically real group. The possibility is discussed that there are two pairs of carbon stars within this group. (auth)

995 STUDY OF A SAMPLE OF FAINT M STARS IN THE DIRECTION OF THE NORTH GALACTIC POLE. Pesch, Peter (Case Western Reserve Univ., Cleveland). Astrophys. J.; 177: No. 2, 519-22(15 Oct 1972).

Slit spectra and UBV photometry of 27 M stars (ranging in V from 9.2 to 15.1) found in Sanduleak's low-dispersion objective-prism survey of the north galactic polar region show that most are nearby dwarfs; only six are halo giants. Since these 27 stars were selected on the basis of not showing appreciable proper motion, it appears that numerous nearby low-velocity M dwarf stars exist. Such stars, which do not show up in proper-motion surveys, increase the space density of intrinsically faint red stars by a significant amount. (auth)

996 STUDIES IN STELLAR STRUCTURE AND STABILITY. Munn, Michael Wilkerson. Santa Barbara, Calif.; Univ. of California (1971). 196p. University Microfilms Order No. 72-25,039.

Thesis.

Several problems involved with analyzing the structure and stability of relativistic stars are considered. First of all, the effects of rotation as manifested in changes in the central density at which various equilibrium configurations become unstable to certain quasi-radial modes of oscillation are considered. These new critical central densities are referenced to those known for nonrotating stars from the Harrison–Wheeler static stability criterion. Following this, a variational principle is given which will allow one to study the equilibrium configurations of rotating, magnetic and elastic stars in relativity. The variational principle applies to those stationary configurations in stable equilibrium for which the energy is an extremum when compared with nearby configurations possessing the same angular momentum, baryon number, and entropy. Lastly, the effects of magnetic fields on the structure of relativistic stars are considered. The Einstein equations which govern the structure are given and numerical calculations are carried out for a specific form of the magnetic field. The quadrupole deformations of the star are given as a result of the numerical work. (Diss. Abstr. Int., B)

997 INFRARED STARS WITH STRONG 1665/1667-MHz OH MICROWAVE EMISSION. Wilson, W. J.; Schwartz, P. R.; Neugebauer, G.; Harvey, P. M.; Becklin, E. E. (Aerospace Corp., El Segundo, Calif.). Astrophys. J.; 177: No. 2, 523-40(15 Oct 1972).

Microwave and infrared observations are presented of seven stars which have strong infrared and 1665- and 1667-MHz main-line OH emission. The sources were selected by the fact that their 1665/1667-MHz OH emission is stronger than any 1612-MHz OH emission. Five of these sources have associated H_2O microwave emission. The sources are associated with M-type long-period variable stars and generally show only a small excess infrared radiation from 3 to 20 μ above that expected from the photosphere. The data are suggestive that both 1665/1667-MHz and 1612-MHz OH/IR stars form a continuous sequence in their intrinsic OH luminosities and their infrared properties. (auth)

998 VIBRATION–ROTATION BANDS OF NH IN THE SPECTRUM OF ALPHA ORIONIS. Lambert, D. L. (Univ. of Texas, Austin); Beer, R.; Astrophys. J.; 177: No. 2, 514–45(15 Oct 1972).

Several lines of the 1–0 and 2–1 fundamental vibration–rotation bands of the NH radical were identified on a high-resolution spectrum of the supergiant α Orionis. (auth)

999 COARSE ANALYSIS OF HD 50896. Van Blerkom, David (Univ. of Massachusetts, Amherst); Patton, Gail. Astrophys. J.; 177: No. 2, 547-54(15 Oct 1972).

A coarse analysis of the He II spectrum of the WN5 star HD 50896 is presented. The model obtained is in agreement with current ideas of the state of excitation, dimensions, and densities characteristic of Wolf–Rayet stars. Intensities of the ultraviolet lines in the Fowler ($n \rightarrow 3$) series, observed by OAO-2, are correctly predicted by the theory. The good agreement between theory and observation argues favorably for the expanding envelope model of Wolf–Rayet stars. (auth)

1000 EFFECT OF URCA SHELLS ON THE DENSITY OF CARBON IGNITION IN DEGENERATE STELLAR CORES. Bruenn, Stephen W. (Florida Atlantic Univ., Boca Raton). Astrophys. J.; 177: No. 2, 459-71(15 Oct 1972).

The Urca process is found to be ineffective in raising ρ_{ign}, the central density at which carbon ignites, in growing degenerate stellar cores unless the relative abundances of "Urca-active" nuclei have been increased far above their cosmic values at some prior evolutionary stage. Evolutionary calculations with increased abundances of "Urca-active" nuclei have been performed, and the effect on ρ_{ign} has been determined. Some implications of these results concerning the subsequent evolution of the core are discussed. (auth)

1001 SYNTHESIS OF NEUTRON-RICH IRON-PEAK NUCLEI. Truran, James W. (Yeshiva Univ., New York). Astrophys. J.; 177: No. 2, 453-8(15 Oct 1972).

The formation of the most neutron-rich stable isotopes in the iron-peak region—^{50}Ti, ^{54}Cr, ^{58}Fe, and ^{64}Ni—by means of weak neutron irradiations in stars and supernovae has been recently found to present difficulties. These nuclei generally are not formed in sufficient quantities under those conditions which give rise to the bulk of the iron-peak nuclei. It is proposed that these isotopes might naturally be formed in neutron-rich equilibria ($\bar{Z}/\bar{N} \approx 0.8$) in matter subsequently ejected in supernova events. Only a relatively small amount of mass need be processed in this manner ($\gtrsim 10^{-4}$ $M_\odot$ per typical supernova event) to account for the observed concentrations of these isotopes in solar-system matter. The character of these equilibria and astrophysical settings under which such conditions might be achieved are briefly explored. (auth)

1002 EINSTEIN REDSHIFT IN WHITE DWARFS. III. Trimble, Virginia (Inst. of Theoretical Astronomy, Cambridge, Eng.); Greenstein, Jesse L. Astrophys. J.; 177: No. 2, 441-52 (15 Oct 1972).

Radial velocities for 74 white dwarfs measured since 1966 are presented. Of these velocities, 51 are classed as reliable and have an average value of +53 km s^{-1}. Six of the stars are in clusters or have distant companions, and so their real radial velocities are known. For these, the average residual redshift is +54 km s^{-1}. The U, V, and W velocities for 102 white dwarfs have mean values of +6, –26, and –4 km s^{-1} and dispersions of ±39, ±24, and ±24 km s^{-1}. Almost half the DA's have $(U^2 + V^2)^{1/2} \geq 50$ or $|W| \geq 30$ km s^{-1}. White dwarfs thus seem to belong to either young or old disk populations or even intermediate Population II. Colors and luminosities have been used to obtain radii for the stars, using two different temperature scales. On an older scale due to Weidemann, the median radius is 0.0145 $R_\odot$. This was too large to produce accord with any theoretical mass–radius relation, given the mean redshift. On a temperature scale based on Shipman's, the median radius is 0.0089 $R_\odot$. This and the average redshift give a mass of 0.65 to 0.87 $M_\odot$, depending on composition, using the Hamada–Salpeter mass-radius relation, and allowing for some uncertainty in both radius and redshift. An instrumental effect appears to account for the systematics of residual velocities of individual Balmer lines. The mean velocity of a star is virtually unaffected. Correcting the individual line velocities for this effect allows one to lower the limits, set by Preston, to the magnetic fields in typical DA white dwarfs to 1 to 2×10^5 gauss. (auth)

1003 CONSEQUENCES OF GRAINS IN THE ATMOSPHERES OF LATE-TYPE STARS. I. INTRINSIC POLARIZATION, INFRARED EXCESSES, AND EMISSION LINES. Jennings, Mark C. Univ. of Arizona, Tucson); Dyck, H. Melvin. Astrophys. J.; 177: No. 2, 427-40(15 Oct 1972).

The suggestion of a relation between Ca II H and K emission and observational indicators of grain material was investigated and confirmed. The H and K reversals and other heavy-element emis-

sion lines, especially those of ionized species, tend to vanish in stars which exhibit intrinsic polarization and infrared excesses. The high incidence of Balmer emission among polarized stars is discussed, but, contrary to previous suggestions, it is found not to be a necessary condition for polarization. It is argued that the disappearance of emission lines implies a weakening of the chromosphere usually associated with late-type stars and that grains are the primary agents responsible for the perturbation. (auth)

1004 EFFECT OF THE CORIOLIS FORCE ON THE STABILITY OF ROTATING MAGNETIC STARS. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 177: No. 2, 423-5(15 Oct 1972).

The effect of the Coriolis force on the stability of rotating magnetic stars in hydrostatic equilibrium was investigated by using the method of the energy principle. It is shown that this effect is to inhibit the onset of instability. (auth)

1005 GENERAL SOLUTION FOR POLARIZED RADIATION IN A HOMOGENEOUS-SLAB ATMOSPHERE. Aronson, Raphael (New York Univ., N. Y.). Astrophys. J.; 177: No. 2, 411-21(15 Oct 1972).

The Transfer Matrix Method is extended to problems of radiative transfer in homogeneous-slab atmospheres in which the transmission and reflection operators are not the same for radiation incident from one side as from the other. This occurs for the azimuthally asymmetric components of the Stokes parameters U and V for polarized light. Physical interpretations of the various operators in the theory are given. (auth)

1006 SPATIAL SPECTROSCOPIC DIAGNOSTIC OF PLANETARY NEBULAE. I. FORMULATION OF SYNTHETIC PROBLEM FOR OPTICALLY THIN LINES. Hekela, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 197-206(1972).

The formation of optical thin lines is used for spatial spectroscopic diagnosis of planetary nebulae in a synthetic approach. The observed quantities are treated as functions of the position on the disk. They are called "local absolute monochromatic intensities" describing the line profile and "local absolute energy" in the emission line expressing the total line radiation. Both quantities are related to 1 cm^2 in the given polar coordinates on the surface of the disk. The observed values are compared with theoretical predictions obtained by means of coarse analysis, ionization structure and fine analysis. Illustrative examples of both local values are given for the N_1 line (OIII – λ 5007 Å) of a hypothetical planetary nebula. (auth)

1007 SPATIAL SPECTROSCOPIC DIAGNOSTIC OF PLANETARY NEBULAE. II. FORMULATION OF THE ANALYTICAL PROBLEM FOR OPTICALLY THIN LINES. Hekela, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 207-18(1972).

The present paper describes and discusses the general analytical method of spatial spectroscopic diagnosis. The method is based on the inversion of the integral equation of the local absolute monochromatic intensity, which expresses the line profile of the emergent radiation from 1 cm^2 column along the line of sight through an optically thin medium. The suggested method allows the physical state of a gas inside the whole investigated volume to be inferred in three dimensions. The main difficulties are connected with the inversion of the Fredholm integral equation of the first kind and the problems of uniqueness, accuracy and resolution of the obtained solutions. Illustrative examples of constraint solutions are given for the N_1 line (O III – λ 5007 Å) of a hypothetical planetary nebula, in order to infer the variation of the population of the upper level along the line of sight. Spherically symmetric and inhomogeneous models are treated. Although the spatial diagnosis was particularly developed for planetary nebulae, it is possible to generalize it to other optically thin extended sources of recent astrophysics. (auth)

1008 IS THE SHELL STAR 88 HERCULIS A BINARY? Harmanec, P.; Koubsky, P.; Krpata, J. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 218-22(1972).

A periodical variability of the radial velocities, determined from the hydrogen lines of the shell, was found on 31 high dispersion spectrograms covering the period from January to December 1971. The best fit is obtained for the period $P = 88.4^d$. The binary hypothesis is advocated as the more probable one. The elements of the hypothetical spectroscopic binary are the following: $P = 88.4^d$, $a_1 \sin i = 1.24 \times 10^7$ km, $f(m_2) = 0.00966\ m_\odot$. (auth)

1009 ORBIT OF THE VISUAL DOUBLE STAR ADS 7896 = JDS 2052 = A 2768. Dommanget, J. (Royal Observatory, Brussels) Astron. Astrophys., Suppl. Ser.; 6: No. 4, 415-18(Aug 1972). (In French).

The orbital elements of the visual binary ADS 7896 = JDS 2052 = A 2768 were computed by using the Thiele–Innes method. The individual observations are given, the residuals as well as an ephemeris concerning the relative positions of the components and their relative radial velocities. From this ephemeris, it appears that spectroscopic observations would be useful around the years 1973–1978, in order to determine the position angle of the ascending node. (auth)

1010 MEAN LIFETIMES AND EQUILIBRIUM ABUNDANCES IN THE FAST CN CYCLE. Caughlan, G. R. (Montana State Univ., Bozeman); Fowler, W. A. Nature (London) Phys. Sci.; 238: No. 80, 23-5(10 Jul 1972).

The "fast CN cycle" occurs under temperature and pressure conditions in which the mean lifetime of ^{13}N to proton capture is comparable with that of ^{13}N to decay by positron emission and may occur in stellar interiors if suitable temperatures exist at the site of hydrogen burning. An analysis is presented of the mean lifetimes and equilibrium abundances for the fast CN cycle and it is shown that production of small N to C ratios is possible, in contrast to the equilibrium production in the ordinary CN cycles, but that associated with such production are high ratios of $^{13}C/^{12}C$ and of $^{15}N/^{14}N$. The final N/C, $^{13}C/^{12}C$ and $^{15}N/^{14}N$ ratios actually depend on the conditions under which cessation of hydrogen burning occurs in astrophysical circumstances. The possibility of the fast CN cycle producing amounts of the CN nuclei different from those produced by the normal or slow CN cycle is discussed. Data are tabulated for proton capture mean lifetimes of CN nuclei and for equilibrium abundances in the fast CN cycle. Of particular interest are the abundance ratios of the stable C and N isotopes. (UK)

1011 INFRARED EXCESSES IN EARLY-TYPE STARS: FREE–FREE EMISSION. Dyck, H. M.; Milkey, R. W. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 84: No. 501, 597-612(Oct 1972).

It has been previously shown that some hot stars exhibit infrared excesses which may be explained by high-temperature ($T \sim 10{,}000°K$) free–free emission. It is demonstrated that the infrared color excesses of many other hot stars may be explained as low-temperature ($T \lesssim 3000°K$) free–free emission. A model is presented for the circumstellar region in which metal atoms are radiatively ionized by the stellar flux and infrared emission occurs from H-minus free–free transitions. (auth)

1012 INFRARED EXCESSES IN SUPERGIANT STARS: EVIDENCE FOR SILICATES. Ney, E. P. (Univ. of Minnesota, Minneapolis). Publ. Astron. Soc. Pac.; 84: No. 501, 613-18(Oct 1972).

It is observed that dust shells emitting the 10- and 20-micron silicate signature are found around late luminous M supergiants where they are probably manufactured by condensation in the stellar atmosphere. They are also found around G supergiants where the condensation is harder to understand. The shell around η Car was probably produced in a violent eruption. The very extended Orion objects surrounding early-type luminous supergiants are probably stellar-heated preexisting material. (auth)

1013 POLARIZATION OF LIGHT BY CIRCUMSTELLAR MATERIAL. Zellner, B. H.; Serkowski, Krzysztof (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 84: No. 501, 619-26(Oct 1972).

An overview is given of the state of the art in the study of circumstellar polarizations, with emphasis on a few of the best-studied and most representative objects. A simple scattering theory for polarization by circumstellar material is described. This theory finds applicability to early-type stars with emission lines in their spectra, to novae, and to red and yellow variables. Highly polarized objects are discussed in some detail. (W.D.M.)

1014 CIRCUMSTELLAR INFRARED EMISSION. Stein, W. A. (Univ. of California, San Diego). Publ. Astron. Soc. Pac.; 84: No. 501, 627-32(Oct 1972).

An attempt is made to summarize what is known about the physics of circumstellar infrared emission and to emphasize those problems that need further investigation. The discussion is limited to the interpretation of the observed infrared results in terms of the physics of the circumstellar regions. (W.D.M.)

1015 FREE–FREE AND BALMER LINE EMISSION FROM OPTICALLY THICK STELLAR SHELLS. Avrett, E. H. (Smithsonian Astrophysical Observatory, Washington, D. C.); Baldwin, J. Rand. Publ. Astron. Soc. Pac.; 84: No. 501, 633-4(Oct 1972).

A circumstellar shell is considered with inner and outer radii, illuminated by a central stellar blackbody radiation field characterized by a temperature. The radiative-transfer and statistical-equilibrium equations are solved for a three-level hydrogen atom. (W.D.M.)

1016 PHOTOMETRIC VARIABILITY OF THE WOLF–RAYET STAR CV SERPENTIS. Morrison, N. D.; Wolff, S. C. (Univ. of

Hawaii, Honolulu). Publ. Astron. Soc. Pac.; 84: No. 501, 635-7 (Oct 1972).

Four-color (uvby) photometry in 1970 and 1971 of CV Ser indicated that the only major light variation (amplitude ~0.16 m) occurs in b, and is apparently caused by variability in the blend of C III lines at λ4652. Continuum measurements in u, v, and y showed a shallow minimum (~0.03 m) at the same phase as minimum light in b. There was no evidence of a secondary minimum in any of the wavelength regions observed. (auth)

1017 POLARIMETRIC METHOD OF MEASURING RADIAL VELOCITIES. Serkowski, K. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 84: No. 501, 649-51(Oct 1972).

Stellar light approaching the spectrometer slit is artificially polarized in such a way that the plane of linear polarization changes rapidly with wavelength. For each resolution element in the spectrum a photon-counting image tube measures the intensity of the light and the position angle of its polarization. Wavelengths determined from these position angles are independent of the position of the stellar image on the spectrometer slit; therefore a wide open slit can be used for radial velocity measurements. An echelle spectrometer on an 80-inch telescope is expected to give a radial velocity accurate to ±1 km sec^{-1} in about four minutes of observing the profile of a spectral line of a 10th magnitude star. (auth)

1018 ORBIT OF 53 TAURI (B9p-Mn). Dworetsky, M. M. (California Inst. of Tech., Pasadena). Publ. Astron. Soc. Pac.; 84: No. 501, 652-5(Oct 1972).

The orbit of the Mn star 53 Tau was determined from measures of 30 Mount Wilson, Lick, and Palomar coudé spectrograms obtained by several observers between 1946 and 1972. 53 Tau has the shortest orbital period yet found for a Mn star, 4.45 d. (auth)

1019 MOTIONS IN THE OUTER LAYERS OF THE 27-DAY CEPHEID T MONOCROTIS. Wallerstein, G. (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 84: No. 501, 656-63(Oct 1972).

Radial velocities and Hα profiles are presented for the entire cycle of T Mon. Several interpretations in terms of rising or falling material are presented, but no simple physical model can be derived and fully justified. The metallic absorption lines show the same depth effects as seen for SV Vul. The lines formed deepest in the atmosphere are accelerated first and the lines formed at highest layers feel the running wave last. The sodium D lines are resolved near minimum light into stellar and interstellar components. (auth)

1020 LIGHT ELEMENTS FOR DK VELORUM: A CORRIGENDUM. Jones, D. H. P. (The Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 84: No. 501, 664-5(Oct 1972).

Jones (1971a) showed that DK Velorum has colors completely at variance with its classification as an RR Lyrae variable star. To confirm the light elements, further observations were made in the 1971–1972 observing season, including many at large hour angles. They are listed on the y system of Jones (1971b). They show that the light elements are JD Hel. (max) = 2441354.250 + 2.48164 E. (W.D.M.)

1021 DIRECT PHOTOMETRIC COMPARISON OF M67 AND HYADES STARS. Sturch, C. (Univ. of Rochester, N. Y.). Publ. Astron. Soc. Pac.; 84: No. 501, 66-8(Oct 1972).

Photoelectric photometry of stars in M67 and the Hyades when transformed to the UBV system implies an observational inconsistency of –0.05 m in (U–B) in published values for the two clusters. If one accepts this correction, the (U–B), (B–V) diagrams for the two clusters are nearly indistinguishable. An interpretation of the new color indices leads to negligible reddening for M67 and a mild metal deficiency. (auth)

1022 TEMPERATURE REVERSAL IN A LTE ATOMSPHERE. Hill, S. J. (Michigan State Univ., East Lansing). Publ. Astron. Soc. Pac.; 84: No. 501, 669-70(Oct 1972).

It is shown that a temperature reversal in a LTE model atmosphere is possible. (auth)

1023 SPECTROSCOPIC OBSERVATIONS OF EZ PEGASI. Irvine, N. J. (Case Western Reserve Univ., Cleveland). Publ. Astron. Soc. Pac.; 84: No. 501, 671-2(Oct 1972).

This G5V variable exhibits short-term fluctuations in the intensity of Hα emission. The star is a possible bright U Geminorum-like system. (auth)

1024 PHOTOMETRIC OBSERVATIONS OF STELLAR RING No. 284. Rettig, T. W. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 84: No. 501, 673-6(Oct 1972).

UBV photometry and objective-prism spectral classifications of stars in stellar ring No. 284 indicate the possibility of the member stars being at a common distance and age, but not at a distance consistent with the stellar ring theory. (auth)

1025 PHOTOMETRY OF THE EARLY-TYPE STARS FROM THE TONANTZINTLA LISTS, NEAR THE SOUTH GALACTIC POLE. Davis Philip, A. G. Publ. Astron. Soc. Pac.; 84: No. 501, 677-9(Oct 1972).

A spectroscopic survey of a 230-square-degree region surrounding the south galactic pole (Sanduleak and Philip, 1968) enabled spectral classifications to be made for the 16 early-type stars in common with the Tonantzintla lists. These stars have now been measured photoelectrically in the Strömgren four-color system. Most of the stars on the list are normal, early-type Population I stars. Four of the stars have δc_1 indices >0.15, implying higher luminosity. (auth)

1026 uvby PHOTOMETRY OF EH LIBRAE. Boardman, W. J. (Birmingham-Southern Coll., Ala.); Heiser, A. M. Publ. Astron. Soc. Pac.; 84: No. 501, 680-4(Oct 1972).

The short-period variable EH Lib was observed photoelectrically in the uvby system. The times of maximum brightness were found to agree, within observational errors, with the elements obtained by Oosterhoff and Walraven (1966). No regular variation was detected in m_1, but an analysis of the (b–y) and c_1 variations indicated an expansion of the star as maximum brightness was reached. The average reddening independent value $[m_1]$ indicated this variable is somewhat similar to the Hyades in its metal content. (auth)

1027 UNUSUAL EMISSION OBJECT AND A NEW S STAR. Bidelman, W. P.; Krumenaker, L. E. (Case Western Reserve Univ., Cleveland). Publ. Astron. Soc. Pac.; 84: No. 501, 685 (Oct 1972).

From a study of several low-dispersion infrared objective-prism spectrograms obtained from 1947 to 1962 with the Burrell Schmidt it seems not unlikely that the object 74 + 1.1° is a very distant and highly reddened P Cygni-type star. (W.D.M.)

1028 PHOTOMETRIC AND SPECTROSCOPIC INVESTIGATION OF SV CENTAURI. Irwin, J. B.; Landolt, A. U. (Louisiana State Univ. Observatory, Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 501, 686-96(Oct 1972).

The β Lyrae-type eclipsing binary SV Cen has been observed photoelectrically and spectroscopically at the Cerro Tololo Inter-American Observatory and is also a double-lined spectroscopic binary. The primary component has the UBV colors of a reddened B1 star, a mass of 9.4, and a mean radius of 6.5 in solar units; the same data for the secondary component are B2, 11.1, and 6.6. There is evidence from the light curves that 22% of the light comes from a third component not seen spectroscopically at primary minimum. The period has decreased 0.14% in the last 75 years and is still decreasing. The variation of period could be caused by orbital motion about a mass of approximately 250,000 solar masses but this hypothesis is also ruled out by radial velocity considerations. The 33.6-year periodicity of the secondary fluctuation in period as studied by O'Connell is not confirmed by the recent times of minima. There is no spectroscopic evidence of gas streams or shells. A prediction ephemeris for 1972 is t_{min} = $JD_{\odot}244139.120 + 1^d.658984$ E. (auth)

1029 NEW ULTRAVIOLET LINE IDENTIFICATIONS FOR EARLY-TYPE STARS. Luebke W. R. Jr. (Yerkes Observatory, Williams Bay, Wis.). Publ. Astron. Soc. Pac.; 84: No. 501, 697-717(Oct 1972).

New data on the energy level systems of C III, N III, and N IV were searched for dipole-allowed transitions coinciding with previously unidentified features in Princeton rocket ultraviolet spectra of early-type stars. Possible identifications are tabulated and discussed. (auth)

1030 HR 6684: A NEW BETA CEPHEI-TYPE VARIABLE STAR. Jerzykiewicz, M. (Lowell Observatory, Mass.). Publ. Astron. Soc. Pac.; 84: No. 501, 718-20(Oct 1972).

HR 6684 has been found to vary in blue light with the period of 0.13989 d. The light range is 0.035 m. The star appears to be a β Cephei variable. If confirmed, it would have the shortest period and lowest luminosity of any previously known β Cephei star. (auth)

1031 PHOTOELECTRIC MONITORING OF BL LACERTAE. Milone, E. F. (Univ. of Calgary, Edmonton, Alberta). Publ. Astron. Soc. Pac.; 84: No. 501, 723-31(Oct 1972).

Photoelectric V observations of BL Lac were obtained with the 50-inch telescope at KPNO during eight nights of June 1970. The light variation generally followed previously reported types of fluctuations, with one exception. A decrease in light of 0.4 m on the night of 3 June (UT) seems to have occurred within four minutes, followed by a recovery 15 minutes later—the recovery itself

lasting less than eight minutes. If real, the time scale of the light variation provides additional evidence for a limited optical-source size and the character and extent of the light variation suggest an eclipse of a compact luminous source. Previously observed night-to-night variations are confirmed, intra-night variations strongly suspected, but no firm confirmation of the flickering reported by Racine (1970) is possible with the present data. (auth)

1032 ASTROPHYSICAL TEST FOR DILATON THEORY OF NON-NEWTONIAN GRAVITY. Sugimoto, Daiichiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 699-700(Aug 1972).

A theory was previously proposed that the dilaton couples to the graviton, and a non-Newtonian part appears in the gravitational potential. An astrophysical test is discussed which determines the range of the non-Newtonian part. As an example the mass-radius relation of white dwarfs is considered. (J.F.P.)

1033 EVOLUTION OF ROTATING STARS. Fricke, Klaus J.; Kippenhahn, Rudolf (Univ., Goettingen, Ger.). Annu. Rev. Astron. Astrophys.; 10: 45-72(1972).

The evolution of a rotating star may be viewed as the parallel evolution of the structure and the angular momentum distribution. The interaction between both entities may be described in terms of redistribution processes for angular momentum. General transport mechanisms are considered along with certain rotation laws produced by these transport processes which may happen to be unstable. Instabilities and induced transport mechanisms are treated and work that explores the implications of the processes upon stellar evolution is reported. These results were obtained mainly by numerical calculations; some are compared with recent observational evidence. (W.D.M.)

1034 ULTRAVIOLET ASTRONOMY. Bless, R. C.; Code, A. D. (Univ. of Wisconsin, Madison). Annu. Rev. Astron. Astrophys.; 10: 197-226(1972).

Since the comprehensive review of ultraviolet astronomy by Wilson and Boksenberg (1969), a large amount of data has become available from rockets and especially from the OAO-2 observations; much of this has been reported in IAU Symposium No. 36 (1970) and in Scientific Results from OAO (1972). An attempt is made to outline some of the developments that have taken place in the last few years. (W.D.M.)

1035 CONVECTION IN STARS. II. SPECIAL EFFECTS. Spiegel, E. A. (Columbia Univ., New York). Annu. Rev. Astron. Astrophys.; 10: 261-304(1972).

A rediscussion is given of stability theory since familiarity with its language is needed to comprehend much of the work on special effects. Some additional background material is discussed. The problem of thermosolutal convection is raised since it provides the clearest example of stability concepts and some thermodynamic problems are discussed, including constitutive relations. The other effects are treated with mention, in some cases, of the joint action of two effects. (W.D.M.)

1036 SHORT TIME-SCALE OPTICAL PULSATIONS IN THE NIGHT SKY BACKGROUND. Bertsch, D. L. (Goddard Space Flight Center, Greenbelt, Md.); Fisher, A.; Oegelman, H. pp 811-16 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A network of monitoring stations designed to detect large-scale fluorescence emission in the atmosphere has been in operation for over two years. The motivation for the search arises from the prediction by Colgate that an energetic photon burst would be produced in a supernova and this burst, when absorbed in the atmosphere, would produce fluorescence. This paper reports on observations up to February 1971. No supernova-like events have been found, although 4.4 were expected. One class of nonfluorescence events is described that evidence suggests is related to electrical discharge in the atmosphere. Another type of nonfluorescence pulse appears to be related to particle precipitation in the atmosphere. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 1058 and 1434.

1037 AUSTRALIAN EAST-WEST BASELINE INTERFEROMETER OBSERVATIONS AT 2.3 GHz. Gubbay, J. S.; Legg, A. J.; Robertson, D. S. (Weapons Research Establishment, Adelaide). Aust. J. Phys.; 25: No. 4, 461-3(Aug 1972).

On October 16 and December 5, 1969, several radio sources were observed using the stations at Island Lagoon near Woomera, and Tidbinbilla. Results are tabulated. (Australia)

1038 IMPROVED POSITIONS AND SOME IDENTIFICATIONS FOR 108 RADIO SOURCES BETWEEN DECLINATIONS -33^0 AND $+27^0$. Merkelijn, Jeannette K. (CSIRO, Epping, Australia). Aust. J. Phys.; 25: No. 4, 451-60(Aug 1972).

Positions of improved accuracy were obtained for 108 sources from the Parkes catalogue between declination $-33°$ and $+27°$. The estimated errors in the positions were less than 15″ arc in both coordinates. Identifications are suggested for 17 sources, 12 with possible quasi-stellar objects and 5 with galaxies. (auth)

1039 HYDROGEN RECOMBINATION LINE AND CONTINUUM OBSERVATIONS AT 5000 MHz OF 13 SOUTHERN H II REGIONS. Caswell, J. L. (CSIRO, Epping, Australia). Aust. J. Phys.; 25: No. 4, 443-50(Aug 1972).

Hydrogen 109α recombination line observations are presented for 13 southern H II regions. For four of these and for one additional H II region new continuum observations at 5000 MHz are also given. Four of the H II regions had previously been incorrectly categorized as supernova remnants. For a number of the other H II regions comparisons are made between the H II velocities and those of associated OH detected in either emission or absorption. (auth)

1040 HYDROGEN LINES IN THE SPECTRUM OF SCORPIUS X-1. Mook, D. E. (Dartmouth Coll., Hanover, N. H.); Edwards, Suzan; Hiltner, W. A. Astrophys. J.; 177: No. 2, L63-8(15 Oct 1972).

Systematic variations in the equivalent widths and profiles of Hα, Hβ, and Hγ and in the Balmer decrement with B magnitude of Sco X-1 are presented. (auth)

1041 21-MICRON OBSERVATIONS OF H II REGIONS. Lemke, D.; Low, F. J. (Max-Planck Institut fuer Astronomie; Heidelberg). Astrophys. J.; 177: No. 2, L53-7(15 Oct 1972).

The 21-μ contour map of M17 is similar to radio maps with three components. Measured flux densities give color temperatures of both 240° and 75°K for the two principal components of M17 and 44°-63°K for Sgr B2, NGC 2024, and DR-21. (auth)

1042 FORMATION OF FILAMENTS IN FOSSIL H II REGIONS. McCray, Richard; Stein, Robert F.; Schwarz, Joseph (Univ. of Colorado, Boulder). Astrophys. J.; 177: No. 2, L75-7(15 Oct 1972).

Ionized filaments of temperature $\sim 10^4$ °K and density contrast ~10 : 1 are formed by thermal instability in a low-density optically thin medium which cools radiatively from an initial temperature $\sim 10^5$ °K. Typical scale lengths are $\sim 0.1/n_0$ pc. The outlying filaments of the Gum Nebula may result from this mechanism. (auth)

1043 HARD X-RAY PULSARS. Harnden, Frank Roderic Jr. Houston, Tex.; Rice Univ. (1972). 202p. University Microfilms Order No. 72-26,417.

Thesis.

Data obtained with balloon-borne x-ray telescopes were examined for evidence of pulsed x radiation in the energy range from 30 to 950 keV. Reported here, along with some findings which have already been published, are three new results: (1) hard x rays have been observed from the region of the Gum Nebula centered on the Vela pulsar; and evidence is presented for (2) the first detection of PSR 0833-45 at any wavelength other than radio, and (3) the measurement, nearly a year prior to the previously earliest measurement, of the period of the Crab Nebula pulsar. A third object, Cygnus X-1, was not found to be periodically pulsating at any of the periods examined; but the time-averaged flux was determined, and upper limits were placed on both periodic pulsations and short-term fluctuations. (Diss. Abstr. Int., B)

1044 ROCKET INFRARED OBSERVATIONS OF H II REGIONS. Soifer, Baruch T.; Pipher, Judith L.; Houck, J. R. (Cornell Univ., Ithaca, N. Y.). Astrophys. J.; 177: No. 2, 315-23(15 Oct 1972).

Infrared observations of three H II regions, made with a rocket telescope cooled by liquid helium are reported. For two of the H II regions multicolor photometry yields very accurate (±2°K) color temperatures. From these temperatures, one is able to rule out grains with infrared absorptivities $\epsilon \propto 1/\lambda^2$ as responsible for the infrared emission in these two nebulae. Good agreement is also found between the infrared luminosities for these three H II regions and the ultraviolet luminosities required to ionize the regions. (auth)

1045 SPECTRA OF SOME OHIO RADIO SOURCES: LIST III. Conklin, E. K. (National Radio Astronomy Observatory, Tucson, Ariz.); Andrew, B. H.; Wills, B. J.; Kraus, J. D. Astrophys. J.; 177: No. 2, 303-7(15 Oct 1972).

Spectra and positions (~15″) are presented for 32 Ohio radio sources. Flux densities were measured at nine frequencies between 0.6 and 85.3 GHz. Several of the sources are variable. (auth)

1046 NONLINEAR INVERSE COMPTON RADIATION AND THE CIRCULAR POLARIZATION OF DIFFUSE RADIATION FROM THE CRAB NEBULA. Arons, Jonathan (Inst. for Advanced Study, Princeton, N. J.). Astrophys. J.; 177: No. 2, 395-410(15 Oct 1972).

A detailed calculation is given of the high-frequency radiation from very relativistic particles moving in a strong, circularly polarized electromagnetic wave. The wave has amplitude E_0 such that $\nu_0 = eE_0/mc\Omega \gg 1$, where Ω is the circular frequency of the wave and m and e are respectively the mass and the absolute value of the charge, and the particle density is assumed to be low enough for vacuum propagation conditions to apply. The particles are assumed to have energies γmc^2 such that $\gamma \gg \nu_0^2$. The resulting radiation is shown to have a degree of circular polarization $\propto \nu_0^{-1}$ independent of the radiated frequency, but the total intensity emitted by a stationary system of electrons, all of which drift at angles greater than $\sim\nu_0/\gamma$ to the propagation direction of the wave, is shown to be identical to synchrotron radiation from relativistic electrons gyrating at large pitch angles in a magnetic field of strength $E_0/\sqrt{2}$. The results are used to show that the circular polarization of this "nonlinear inverse Compton" mechanism, when combined with the vacuum oblique-rotator approximation for pulsar environments, may be in disagreement with observational upper limits on the fractional circular polarization of the diffuse emission from the Crab Nebula. (auth)

1047 SIMPLE ANALYTIC APPROXIMATION FOR DUSTY STROEMGREN SPHERES. Petrosian, Vahe (Stanford Univ., Calif.); Silk, Joseph; Field, George B. Astrophys. J.; 177: No. 2, L69-73(15 Oct 1972).

Recent far-infrared observations of H II regions are interpreted in terms of true absorption by internal dust of a significant fraction of the Lyman-continuum photons. Approximate analytic expressions are presented describing the effects of internal dust on the ionization structure of H II regions, and a procedure is outlined for deducing the properties of this dust from optical and infrared observations. (auth)

1048 DECIMETRIC SPECTRA OF EXTRAGALACTIC RADIO SOURCES. Condon, James Justin. Ithaca, N. Y.; Cornell Univ. (1972). 271p. University Microfilms Order No. 72-26,341.

Thesis.

Flux density measurements of extragalactic sources in samples statistically complete to 9 flux units at 178 MHz, 3 flux units at 430 MHz, 2 flux units at 1400 MHz, and 0.35 flux units at 2700 MHz were made at Arecibo. The principal observing frequency was 318 MHz, where strongly confusion-limited observations were made with a 16 arc min beam. A detailed study of the confusion error was made analytically on the basis of Scheuer's method and also statistically by a Monte Carlo simulation, and the 318 MHz flux density errors were found to be only 4% plus 0.14 flux units confusion. The spectral index distributions from each sample were tested for flux density dependence, and it was found that the median spectral index of the normal spectrum sources in the 2700 MHz sample increases significantly for sources weaker than 0.8 flux units at that frequency. Almost all of the identified radio galaxies studied have normal spectra, while many of the quasars in the high frequency samples have relatively flat spectra. Sources in the 2700 MHz sample can be classified as galaxies or quasars with 85% accuracy on the basis of their radio spectra alone. (Diss. Abstr. Int., B)

1049 ABSOLUTE TIMING OF TWELVE PULSARS. Richards, David William. Ithaca, N. Y.; Cornell Univ. (1972). 198p. University Microfilms Order No. 72-27,969.

Thesis.

Shortly after the first pulsars were reported in 1968, precision timing of several of these objects was initiated at the Arecibo Observatory, Arecibo, Puerto Rico. The 1000-foot reflector was operated at frequencies between 111.5 and 430 MHz to measure absolute times of arrival from pulsars NP0527, NP0532, AP0823, CP0834, CP0950, CP1133, AP1237, AP1541, CP1919, PSR1929, JP1933, and AP2015. The intent of the observations was to obtain data necessary to determine periods, time derivatives of periods, and positions, where possible, in order to clarify the nature of pulsars. The pulse times-of-arrival (TOA's) were referenced to Loran-C signals of the U. S. Coast Guard and determined by cross-correlation with templates representing assumed pulse shapes. The TOA's were reduced to the reference frame of the solar system barycenter and then fitted by least squares to a function assumed to describe pulse phase as a function of time, position error and other parameters. Results obtained include new positions for NP0527, AP1237, and AP1541; second derivative of period for NP0532 (Crab Nebula pulsar); first derivative of period for all twelve pulsars; and observations of unusual phase fluctuations for NP0532. (Diss. Abstr. Int., B)

1050 CENTAURUS X-3, POSSIBLE REACTIVATION OF AN OLD NEUTRON STAR BY MASS EXCHANGE IN A CLOSE BINARY. Van Den Heuvel, E. P. J.; Heise, J. (Astronomical Inst., Utrecht). Nature (London) Phys. Sci.; 239: No. 92, 67-9(2 Oct 1972).

An upper limit of $0.7 \pm 0.14\ M_\odot$ is obtained for the mass of the pulsar component of Cen X-3. The system is likely to be a massive close binary in the second state of mass exchange. (auth)

1051 PULSARS. Smith, F. G. (Univ. of Manchester, Jodrell Bank, Eng.). Rep. Progr. Phys.; 35: No. 4, 399-461 (1972).

A review is presented of the observational data on pulsars, and the interpretations which can be made directly from them. Introductory sections describe the discovery of the first pulsars, the search techniques now in use, the theory of neutron stars, and the relation between the Crab nebula pulsar and the nebula itself. A general description of the pulse observations, with a discussion of the accurate timing, leads to a detailed account of the radio observations, and particularly the pulse shapes and polarizations. Scintillation and Faraday rotation measurements are discussed, leading to a description of the ionized interstellar medium and the galactic magnetic field, and to the suggestion that pulsars have a high velocity relative to interstellar gas. The descriptions of pulse shapes and polarizations are then related to various geometrical theories of the location of emitting regions on a rotating neutron star. The beaming mechanism and the emission mechanism are discussed in the light of these geometrical considerations. Finally, the population of the pulsars within the galaxy is discussed in relation to the probable association between pulsars and the supernova remnants. Comprehensive tables of positions, periods, and other characteristics of all pulsars known in early 1972 are presented, with references. (auth)

1052 NEWEST PROBE OF THE RADIO UNIVERSE. Mitton, S. New Sci.; 56: No. 816, 138-40(19 Oct 1972).

A new five-kilometer radio telescope has come into operation at Cambridge. This instrument maintains Britain's lead in the ability to map structural details of cosmic gas clouds, radio galaxies, and quasars. It will be used to investigate high-energy processes deep in the universe. (UK)

1053 ELECTRON BREMSSTRAHLUNG FROM HOT PLASMA IN THE PRESENCE OF STRONG MAGNETIC FIELD. El-Gowhari, A.; Arponen, J. (Univ. of Helsinki). Nuovo Cim.; 11B: No. 2, 201-14(11 Oct 1972).

Relativistic expressions are given for the high-frequency electromagnetic radiation due to bremsstrahlung in the presence of a strong magnetic field ($\leq 10^{11}$ G), and the nonrelativistic limit is also considered. The results are applied to the case of a hot plasma in a magnetic field. It is suggested that the results can explain the pulsed x-ray and γ-ray radiation from x-ray pulsars like NP 0532. (auth)

1054 SUPERNOVA REMNANTS. Woltjer, L. (Columbia Univ., New York). Annu. Rev. Astron. Astrophys.; 10: 129-58 (1972).

The extended galactic nonthermal radio sources show many morphological and spectral similarities with known supernova remnants and as a consequence it seems not unreasonable to consider them also as supernova remnants. Topics considered include a catalog of SNR, description of individual remnants, the Σ–R diagram, hydrodynamic evolution of SNR, filamentary shells, radio evolution, x-ray emission, and galactic effects. (W.D.M.)

1055 PULSARS: STRUCTURE AND DYNAMICS. Ruderman, M. (Columbia Univ., New York). Annu. Rev. Astron. Astrophys.; 10: 427-76(1972).

This review resurveys and emphasizes general theoretical notions of pulsar structure and their consequences rather than observational details and models of radio pulses. Main topics covered include general properties, magnetosphere, neutron stars, dynamics, evolution, glitches, and period fluctuations. (W.D.M.)

Solar Phenomena

Refer also to abstracts 922, 944, 952, 955, and 1436.

1056 PLASMA EMISSION PROCESSES IN A MAGNETO-ACTIVE PLASMA. Melrose, D. B.; Sy, W. N. (Australian National Univ., Canberra). Aust. J. Phys.; 25: No. 4, 387-402(Aug 1972).

Plasma emission (i.e. emission at about the plasma frequency and twice this frequency) is treated taking into account the effects of the magnetic field on the electron plasma waves, on the conversion processes, and on the escaping radiation. The expected degrees of polarization of the fundamental and second harmonic are calculated in the weak field limit. The results are used to estimate the magnetic field strength B at the 80 MHz level from the observed polarization of solar type III bursts; the result B < 0.04 G is smaller than previous estimates. The possible importance of electron-cyclotron waves in an application to type I bursts is noted. (auth)

1057 PRODUCTION OF LIGHT ELEMENTS IN THE SOLAR SYSTEM. Koike, Chiyoe (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 66-77(Jul 1972).

In order to make clear the early history of the solar system, the production of light elements Li, Be, and B by solar cosmic rays are studied. The isotopic ratios of Li and B can be explained by assuming the dominance of the alpha–alpha reactions and the spallation by protons, respectively, induced by high-rigidity solar cosmic rays, the characteristic rigidity R_0 being 450 to 700 MV and the alpha–proton ratio j_α/j_p being $1 \sim 1/6$. As there is no experimental data of $\alpha-\alpha$ reactions at this high-energy region, their cross sections are estimated from those of inverse reactions such as (p, α), (d, α), and (np, α) for intermediate weight nuclei. The absence of the spallation by alpha particles is explained by assuming an inhomogeneous model that the target material rich in H and He gases encloses the target material rich in CNONe, and heavier nuclei, and the proton flux can reach the inner region but the alpha flux stops in the outer layer before it interacts with heavier elements. The planets might pass such an inhomogeneous model in their formation stage. (auth)

1058 ENERGY SPECTRUM OF SMALL-SCALE IRREGULARITIES IN THE INTERPLANETARY PLASMA. Lotova, N. A. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 6, 826-31(1972). (In Russian).

The relationship is derived between the scintillation spectra of small-diameter radio sources and the energy spectrum of irregularities in the interplanetary plasma; the latter spectrum is characterized by the distribution of energy as a function of the turbulence scale a_k. It is concluded that the value of the index α in the power law energy spectrum of small-scale irregularities is on the average restricted to the interval of $1 \leq \alpha \leq 5$. (auth)

1059 SOLAR ROTATION: THE PHOTOSPHERIC HEIGHT GRADIENT. Livingston, W.; Milkey, R. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 25: No. 2, 267-73 (Aug 1972).

For selected pairs of Fraunhofer lines the height of formation has been calculated corresponding to that portion of the profile intercepted by the magnetograph exit slits. A photospheric height discrimination of 150 to 300 km is realized. In 1971 simultaneous measurements of equatorial angular velocity from spectroscopic displacements of these line pairs indicate no height gradient in excess of 1%. The disturbing influence of telluric line blends is analyzed. It is proposed that undetected telluric lines could account, at least in part, for the photospheric height gradient which has been found in a number of photographic investigations. (auth)

1060 CALCULATION OF THE H(a,v)-FUNCTION. Gerbil'skij, M. J. (Main Astronomical Observatory, Kiev). Solar Phys.; 25: No. 2, 274-6(Aug 1972).

For the computer analysis of absorption lines it is necessary to have a convenient and exact expression for calculation of the H(a,v) function over a wide range of values of the parameters a and v. A method of calculation is given. (W.D.M.)

1061 EMPIRICAL DETERMINATION OF LINE SOURCE FUNCTIONS, β_L-VALUES, AND THE MICROTURBULENT AND CONVECTIVE VELOCITY COMPONENTS AS FUNCTIONS OF DEPTH IN THE PHOTOSPHERE–CHROMOSPHERE TRANSITION REGION. De Jager, C. (Astronomical Inst., Utrecht); Neven, L. Solar Phys.; 25: No. 2, 277-304(Aug 1972).

An empirical method for determining line source functions, previously applied to the cores of infrared lines was extended to the whole line profile and was applied to center-limb observations of sixteen lines of five infrared multiplets, mainly of high excitation potential. The present investigation was performed in two steps. Approximate values were derived for the depth dependence of the four functions where β_L is the ratio between the actual and the LTE population of the lower level of the transitions involved. These empirically derived functions were used to compute the line profiles. From the remaining differences between observed and computed profiles, corrections were derived to the four functions. The main results were: (a) Convective velocities. (b) (Micro-)turbulent velocities. Between $\tau_5 = 10^{-4}$ and 10^{-1}: $\langle v_r \rangle \approx 1.4$ km s^{-1}, which was an upper limit since an unknown contribution of macroscopic motions could not be separated. (c) Line source functions. The source functions were close to the blackbody function for $\tau_5 \gtrsim 10^{-3}$, slight deviations occurred in higher levels. The interesting behavior of the Ca II source function near $\tau_5 = 10^{-5}$ should be noted. (d) Non LTE-functions: first approximations for the functions $\log \beta_L(\tau_5)$ were derived empirically, and are shown; the second approximation shows them to be too large and the real values seem to be closer to one-half or one-third of these functions. (auth)

1062 ADJUSTMENT OF OUTER SOLAR LAYER MODELS. Krinberg, I. A.; Teplitskaia, R. B. (Siberian Inst. of Terrestrial Magnetism, Ionosphere and Radio-Wave Propagation, Irkutsk, USSR). Solar Phys.; 25: No. 2, 305-18(Aug 1972).

Using the electron density n_e as an independent variable, agreement between the models of the convective zone, photosphere, chromosphere, corona, and solar wind is obtained. As a base the known data about the mean models of the individual layers of the quiet Sun are taken (i.e., without taking account of inhomogeneities and deviations from spherical symmetry). The chromospheric region is the exclusion. Here the run of $T_e(n_e)$ is revised anew to provide a smooth transition from temperature minimum to the corona and to satisfy the observed intensity distribution in the shortwave radio emission spectrum. A plot of the gas density ρ versus n_e permits to get a clear representation about the rate of change of the degree of ionization x and to evaluate quickly the numerical values of x. (auth)

1063 TEMPERATURE STRUCTURE AND CONDUCTIVE FLUX IN THE CHROMOSPHERE–CORONA TRANSITION REGION. Elwert, G.; Raju, P. K. (Univ., Tubingen, Ger.). Solar Phys.; 25: No. 2, 319-28(Aug 1972).

Observations of uv-line intensities referring to the whole undisturbed Sun were used to investigate the chromosphere–corona transition region. For the evaluation of the integral representing the theoretical line intensities it appears to be an improvement to consider not the temperature gradient but the conductive flux to be nearly constant in the line-forming region. The variation of conductive flux with temperature calculated in this way is indeed small. Moreover, in the conductive flux versus temperature diagram the scatter of points is found to be less with coronal values of relative abundances than with photospheric ones. The results are used for determining the temperature structure of the transition region. (auth)

1064 TUNNEL-EFFECT AND PROPAGATION OF 5-MIN OSCILLATIONS IN THE SOLAR ATMOSPHERE. Zhugzhda, Y. D. (IZMIRAN, Moscow). Solar Phys.; 25: No. 2, 329-38(Aug 1972).

Tunneling of surface waves (which are also called "nonpropagating" or "evanescent mode") in isothermal atmosphere is considered. Tunneling of 5-min oscillations in solar atmosphere is discussed. Phase lead of chromospheric oscillations with respect to photospheric oscillations (Tanenbaum et al., 1971) can be explained by tunneling only. (auth)

1065 QUASI-PERIODIC COMPONENTS WITH PERIODS FROM 30 TO 60 MIN OF AMPLITUDE FLUCTUATIONS OF X-BAND SOLAR RADIO EMISSION. Kobrin, M. M.; Korshunov, A. I. (Radiophysical Research Inst., Gorky, USSR). Solar Phys.; 25: No. 2, 339-42(Aug 1972).

Special experiments were performed to investigate the fluctuations of the intensity difference of the solar radio emission at two close frequencies. The autocorrelation functions and their spectra were obtained. The latter showed the presence of quasi-periodical components with periods of about 50 min in the solar radio emission. The possibility of explaining the observed quasi-periodical components by the supergranulation oscillations and the solar self-oscillations is considered. (auth)

1066 RESULTS OF CORONAL INVESTIGATION AT THE SEPTEMBER 22, 1968 SOLAR ECLIPSE. Khetsuriani, Ts. S.; Tetruashvili, E. I. (Abastumani Astrophysical Observatory, Georgia, USSR). Solar Phys.; 25: No. 2, 343-6(Aug 1972).

The 1968 Abastumani Astrophysical Observatory Solar Eclipse Expedition obtained photographic records of the polarization and intensity of the solar corona on September 22 from a site of the

South Urals (Western Siberia). A photometric study of the corona was carried out. Polarization was computed both in a total corona and in some of its streamers. The coronal intensity I_K and I_F components were separated. Electron concentrations and temperatures were computed. (auth)

1067 SOLAR BRIGHT POINTS IN 3840 A AND Hα. Vorpahl, Joan; Pope, Thomas (Carnegie Inst. of Washington, D. C.). Solar Phys.; 25: No. 2, 347-56(Aug 1972).

Analysis of bright features in 3840 Å and Hα shows that for every Ellerman bomb (Hα−0.9 Å) there is a cospatial brightening in the 3840 Å network. Properties of these bright points are given in both wavelengths. The appearance, and subsequent separation, of new elements in the 3840 Å network and the direct transition from a 3840 Å bright point to a new sunspot are described. (auth)

1068 PHYSICAL PROPERTIES OF SOLAR CHROMOSPHERIC PLAGES. I. LINE PROFILES OF THE Ca II H, K, AND INFRARED TRIPLET LINES. Shine, Richard A.; Linsky, Jeffrey L. (Univ. of Colorado, Boulder). Solar Phys.; 25: No. 2, 357-79(Aug 1972).

Double pass photoelectric observations are presented of five Ca II lines (H, K, 8498 Å, 8542 Å, and 8662 Å) in a number of solar plages of different degrees of activity, quiet regions, and a sunspot. The data are compared with previous work. All five lines show increasing emission together in plages and the least opaque of the infrared triplet lines appears to exhibit core emission prior to the more opaque members of the multiplet. The question of source function equality is considered and the differences and similarities among plage profiles and between plage and quiet profiles are shown qualitatively and quantitatively. (auth)

1069 VELOCITY OSCILLATIONS IN SOLAR PLAGE REGIONS. Chen, Cheng-jen; Lykoudis, Paul S. (Purdue Univ., Lafayette, Ind.). Solar Phys.; 25: No. 2, 380-401(Aug 1972).

The properties of wave propagation in a perfectly electrically conducting, plane-stratified, inviscid, compressible atmosphere permeated by a horizontal magnetic field which varies with height were investigated. It is shown that a diagnostic diagram can be constructed through a generalization of the propagation equation to account for the presence of a magnetic field. The effect of the magnetic field on the oscillations in solar plages around the temperature minimum was studied and compared with the nonmagnetic case based on the Bilderberg Continuum Atmosphere. Due to the joint action of ionization and the magnetic field, a potential well for internal gravity waves is formed. The properties of the trapped waves are in qualitative agreement with the observations. The Brunt–Väisälä frequencies in the presence (N) and absence (N_0) of the magnetic field around the temperature minimum are shown to obey the relation $N/N_0 \approx (1 + \beta^2)^{-\frac{1}{2}}$, where β is the ratio between the Alfvén and the sonic speeds. The modified Brunt–Väisälä frequency (N) is decreased as the strength of the magnetic field increases. The magnetic effect makes the potential well shallower, thus shrinking the domain for the trapped gravity modes. (auth)

1070 LOOP PROMINENCE OF MAY 13, 1971 AND ITS ASSOCIATED EFFECTS. Machado, M. E.; Gallegos, H. Grossi; Silva, A. (Observatorio Nacional de Fisica Cosmica, San Miguel, Argentina). Solar Phys.; 25: No. 2, 402-12(Aug 1972).

A study is presented of the formation of a loop prominence system (LPS) on May 13, 1971. The development of the phenomenon was found to be consistent with the model of Jefferies and Orrall, and was associated with small radio bursts and several kinds of SID. From the spectral analysis a temperature of 13200°K was deduced and a density of hydrogen atoms $n(H) \approx 10^{10}$ cm^{-3} estimated. The existence of inclined emissions probably produced by rotatory motions is discussed. From the radio data analysis it was inferred that an impulsive and a thermal component were present; the length of the emitting plasma cloud was found to be about 56000 km. The LPS appeared, in accordance with previous results, in a region producing proton flares. (auth)

1071 COLD EMISSIONS IN SOLAR CORONA. Leroy, Jean-Louis (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France). Solar Phys.; 25: No. 2, 413-17(Aug 1972). (In French).

Prominences were photographed through a coronagraph and an Hα Lyot filter with long exposure times. Faint Hα emissions are often detected down to the threshold 2×10^{-6} times of the Sun's brightness; they show definite structures but their relations to the low-level ordinary prominences are not very clear. Estimates are given for the density and thickness of such cool regions. (auth)

1072 IMPULSIVE X-RAY BURST OF OCTOBER 10, 1970. Kane, S. R. (Univ. of California, Berkeley); Kahler, S. W.; Kurfess, J. D. Solar Phys.; 25: No. 2, 418-24(Aug 1972).

An impulsive burst of 100- to 400-keV solar x-rays associated with a small solar flare was observed on October 10, 1970 with a large area scintillator aboard a balloon floating at an altitude of 4.2 g cm^{-2} above the Earth's surface. The x-ray burst was also observed simultaneously in 10- to 80-keV range by the OGO-5 satellite and in 8 to 20-Å range by the SOLRAD-9 satellite. The impulsive x-ray emission reached its maximum at ~1643 UT at which time the differential photon spectrum in the 20- to 80-keV range was of the form $2.3 \times 10^4\ E^{-3.2}$ photons cm^{-2} s^{-1} keV^{-1} at 1 AU. The event was attributed to a Hα-subflare located approximately at S13, E88 on the solar disc. The spectral characteristics of this event were examined in the light of the earlier x-ray observations of small solar flares. (auth)

1073 POLARIZATION OF HARD X-RAYS FROM SOLAR FLARES. Haug, Eberhard (Univ., Tuebingen, Ger.). Solar Phys.; 25: No. 2, 425-34(Aug 1972).

The polarization of hard solar x radiation (>10 keV) is calculated on the assumption that electrons get a nonisotropic velocity distribution in the initial phase of a flare. The bremsstrahlung generated by nonthermal electrons spiralling around magnetic field lines with discrete pitch angles is considerably polarized if observed at approximately right angles to the magnetic field. In the energy range from 10 to 50 keV the degree of polarization is not strongly dependent on the photon energy. For pitch-angle distributions of the form $\sin^2\alpha$ and $\cos^2\alpha$, the polarization has opposite signs; it decreases appreciably at high photon energies. The observation of x-ray polarization will be useful in deducing the physical conditions in flares. (auth)

1074 ROLE OF ENERGETIC ELECTRONS IN THE CORRELATION OF METER AND DECIMETER TYPE III BURSTS WITH 4 keV X-RAY EMISSION. Kahler, S. W. (Naval Research Lab., Washington, D. C.). Solar Phys.; 25: No. 2, 435-51(Aug 1972).

The correlation of Type III burst-groups with 4 keV solar x-ray emission is examined. A total of 151 burst-groups reported by the Fort Davis Observatory were compared with x-ray emission observed by the Naval Research Laboratory experiment on the OGO-5 satellite. A higher x-ray correlation is found for Type III burst-groups when: (1) the bursts are observed on the decimeter band and (2) the bursts are more intense. The bremsstrahlung flux resulting from the proposed coronal loss of the E < 10 keV Type III electrons is shown to be below the detection threshold of the OGO-5 experiment. No fine structure is found in the correlated impulsive x-ray bursts with a time scale on the order of one second. It is proposed that electrons are accelerated over a time of 10 to 100 s or more and that the Type III bursts are the result of the occasional escape of a small fraction of the energetic electrons from the acceleration region. (auth)

1075 SEARCH OF A CONNECTION BETWEEN THE POLARIZATION OF DECAM-TYPE III BURSTS AND MAGNETIC FIELDS IN DIFFERENT HEIGHTS OF THE SOLAR ATMOSPHERE. Chertok, I. M. (IZMIRAN, Moscow); Fomichev, V. V.; Krueger, A.; Willimczik, W. Solar Phys.; 25: No. 2, 452-60(Aug 1972).

Polarization measurements of Type III bursts at 23.5 and 29.5 MHz have been compared for several years with indicators of magnetic fields in different height levels such as sunspot data, S-component characteristics, and noise storm data. By applying the Mount Wilson and Brunner types of the related spot groups there results a positive relationship between the average degree of Type III burst polarization and the magnitude or complexity of photospheric magnetic fields. For other parameters (leading spot area, peak intensity of the S-component at 9.1 cm wavelength) such a clear monotonic relation has not been found. Possibly the degree of polarization is influenced by height variations of the emitting level of the Type III bursts at a fixed frequency due to variable electron densities. No connection has been detected between the Type III burst polarization and noise storm fluxes which may be due to the local distance of the origin of both emissions. (auth)

1076 PARTICLE MOTIONS IN CORONAL STREAMERS AND TYPE III RADIO BURSTS. Smith, Dean F.; Pneuman, G. W. (High Altitude Observatory, Boulder, Colo.). Solar Phys.; 25: No. 2, 461-77(Aug 1972).

Both individual and collective motions of electron and proton streams in the current sheet which is thought to exist near the center of a coronal streamer are considered. Unlike previous analyses, closed field lines which must exist when finite conductivity is taken into account as well as a B_ϕ field due to solar radiation are present. It is shown on the basis of individual particle motions that neither electrons nor protons could move in most of the sheet in the manner required to explain Type III bursts since they are effectively tied to the closed field lines. The possibility that the stream could collectively drag the closed field lines out with itself is considered. It is shown that impossibly high densities are required for electron streams and im-

probable densities for proton streams. Thus the particles responsible for Type III bursts cannot travel in the densest part of a coronal streamer, but presumably travel close to this region. Moreover, the current sheet cannot act as a channeling agent to help explain the transverse coherency of Type III burst sources. (auth)

1077 SPECTRAL BEHAVIOUR AND PROTON EFFECTS OF THE TYPE IV BROAD-BAND CONTINUA. Boehme, A. (Heinrich-Hertz-Institut, Potsdam, Ger.). Solar Phys.; 25: No. 2, 478-88(Aug 1972).

The spectral behavior of a group of broad-band continua at meter and decameter waves is discussed. These broad-band continua are polarized in the extraordinary mode and occur during the explosive phase of some strong flares. The time behavior of the broad-band continua and of the moving Type IV bursts was compared in a previous paper (Böhme, 1972). It is pointed out that the broad-band continua differ from the moving Type IV bursts not only regarding their time behavior but also with reference to some spectral characteristics. Moreover, the broad-band continua differ from the moving Type IV bursts by their close relation to proton events. It can be concluded that the high-energy protons are accelerated in different steps. An important secondary acceleration mechanism acts above the emission level of the Type IV μ bursts. (auth)

1078 SOLAR CYCLE VARIATION AND N–S ASYMMETRY OF λ5303 CORONAL INTENSITY. Pathak, P. N. (Physical Research Lab., Ahmedabad, India). Solar Phys.; 25: No. 2, 489-92(Aug 1972).

It is shown that during the present solar cycle (No. 20), the λ5303 coronal intensity at heliographic latitudes between 15 to 40° in both hemispheres had two maxima. The first maximum occurred in 1967–68 and the second in 1969–70. At lower latitudes ($\approx \pm 10°$) there was only one clear maximum in 1970. These results are in good agreement with those of Gnevyshev (1967) for the previous solar cycle. The north–south asymmetry of λ5303 intensity for the period 1957–1970 is studied and its implications to solar–terrestrial relationships are discussed. It is shown that during the period studied, the N–S asymmetry of λ5303 intensity is negatively correlated with sunspot activity. (auth)

1079 EVIDENCE FOR TWO MAXIMA OF ACTIVITY IN THE 20TH SOLAR CYCLE. Cuperman, S. (Univ. of Maryland, College Park); Sternlieb, A. Solar Phys.; 25: No. 2, 493-7(Aug 1972).

Analysis of the 5303 Å coronal line intensity and of the sunspot activity during the period 1962–1970 confirms the existence of two distinct maxima of solar activity, in accordance with the previous findings of Gnevyshev for the period 1954–1960. (auth)

1080 EVIDENCE FOR AN ULTRA-LONG CYCLE OF SOLAR ACTIVITY. Henkel, R. (Univ., Frankfurt am Main). Solar Phys.; 25: No. 2, 498-9(Aug 1972).

The existence of an ultralong cycle of solar activity to which the already known 80-year cycle is subjected is shown. This ultralong cycle expresses itself in the variations of the duration D_M of the 11-year cycles as measured between two minima. (W.D.M.)

1081 LONG-LIVED SECTORS OF ENHANCED DENSITY IRREGULARITIES IN THE SOLAR WIND. Houminer, Z.; Hewish, A. (Cambridge Univ., Eng.). Planet. Space Sci.; 20: No. 10, 1703-16(Oct 1972).

Observations of interplanetary scintillation on 32 radio sources over a period of 8 months indicate the presence of enhanced scintillation sectors that usually persist for one solar rotation or longer. The sectors are aligned along the spiral magnetic field over distances of 0.5 to 1.3 au from the Sun and have a typical width of 3 days at the Earth. Enhanced scintillation sectors lead high solar-wind velocity streams by about 3 days and may be associated with enhanced plasma density regions detected by space craft. The sectors extend to heliocentric latitudes of 50° and give some evidence of shearing caused by differential rotation. Observations of the power spectrum of the scintillations confirm that the size of the irregularities that cause scintillation increases as the solar wind increases. This result, and an observed correlation of the spectrum width and scintillation index, provides evidence that the irregularity scale is related to the ion gyroradius. (auth)

1082 FIVE-MINUTE OSCILLATIONS AS NONRADIAL PULSATIONS OF THE ENTIRE SUN. Wolff, Charles L. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 177: No. 2, L87-92(15 Oct 1972).

Calculations of the stability coefficient show that the Sun should be pulsating as a unit in nonradial modes of high order. The pulsations are driven by the superadiabatic gradient of the low photosphere and by the same sensitive changes in opacity that are known to be important in variable stars. The existence of solar pulsations can explain many of the large-scale features observed in the well known 5-minute oscillations of the solar atmosphere. (auth)

1083 DYNAMICAL MODEL OF THE SOLAR CORONA. Browne, Stephen Laurence. Laramie, Wyo.; Univ. of Wyoming (1972). 185p. University Microfilms Order No. 72-26,502. Thesis.

The hydrodynamic equations for an ideal, inviscid, fully ionized hydrogen gas in a gravitational, but not magnetic, field are solved by an explicit Lax–Wendroff two-step technique using one-dimensional slab symmetry. Radiation and thermal conductivity are included. The model spans 100,000 km starting from the chromosphere–corona transition region. An initially isothermal gas is seen to evolve coronal properties in 4000 seconds, by which time it settles into dynamic equilibrium characterized by a 2000 km transition region, a temperature maximum of 1.6×10^6 °K at a height of 60,000 km, and a solar wind mass flux of 10^{-9} gm/cm^2 sec. (Diss. Abstr. Int., B)

1084 OSCILLATOR STRENGTHS AND GROUND-STATE PHOTOIONIZATION CROSS-SECTIONS FOR Mg^+ AND Ca^+. Black, John H.; Weisheit, Jon C.; Laviana, Ellen (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 177: No. 2, 567-72(15 Oct 1972).

Oscillator strengths and ground-state photoionization cross-sections were computed for Mg^+ and Ca^+. The polarization interaction between the valence electron and the core was included in the calculations in a consistent manner. In some cases this interaction significantly changed the computed results. For many of the transitions considered, there exist no other published oscillator strengths. (auth)

1085 CHARACTERISTICS OF THE QUIET SOLAR WIND BEYOND THE EARTH'S ORBIT. Cuperman, S. (Univ. of Colorado, Boulder); Harten, A.; Dryer, M. Astrophys. J.; 177: No. 2, 555-66(15 Oct 1972).

Solutions of one-fluid model equations for the quiet solar wind between 1 and 12 AU are presented. The solar wind is treated as a steady spherically expanding flow, and effects such as viscosity, magnetic fields, solar rotation, interaction with the interstellar medium, and fluctuations are neglected. The predicted profiles of the gross features of the solar wind match the existing observations at two particular points: at the "singular" critical distance, r_c^* (about 5.9 $R_\odot$), and at 1 AU. The matching of the theoretical solutions to the observations between r_c^* and 1 AU is obtained by using a "modified" (essentially noncollisional) thermal conductivity. The functional dependence of the modified thermal conductivity thus determined is assumed to be valid also for distances $r > 1$ AU. The results of the integration in the range $1 \leq r \leq 12$ AU are presented in both graphical and numerical form. The total energy flux as well as the profiles of the various individual contributing energy fluxes are included in these results. In particular, the predicted gross features of the solar wind at distances representing the semimajor axes of the orbits of planets are indicated. These last values are also compared with those obtained from the solution of one-fluid model equations with pure collisional thermal conductivity. Analytical expressions describing the space dependence of the solutions obtained are also discussed. It is found, for example, that the radial dependence of temperature approaches the adiabatic form, $r^{-4/3}$, as a consequence of the zero temperature and thermal conduction requirement at $r = \infty$. Finally, values of the gross features of the solar wind at distances larger than 12 AU are presented. They are obtained by the extrapolation of those which resulted from the direct integration up to 12 AU noted above. (auth)

1086 FLUCTUATION–DISSIPATION THEOREM AND KINEMATIC-DYNAMO ACTIVITY. Lerche, I. (Univ. of Chicago). Astrophys. J.; 177: No. 2, 309-13(15 Oct 1972).

Using the dispersion relation obtained elsewhere describing the regeneration of large-scale magnetic fields under isotropic velocity turbulence, the equations describing the response of the system to an arbitrary externally applied current distribution are set up. It is demonstrated that the absorption coefficient (which characterizes the rate at which the impressed current supplies power) may be either positive or negative depending on the level of turbulence. A positive absorption coefficient corresponds to a system in which the turbulent generation of field (through the action of the Lorentz force $v \times B$) is not rapid enough to overcome resistive losses, while a negative absorption coefficient implies that regeneration by the turbulent Lorentz force exceeds resistive losses. This calculation was done to simplify the "search" criteria that must otherwise be employed (for given, but arbitrary, forms of the correlation function describing the isotropic turbulent velocity pattern) when one is interested in determining whether a particular correlation function gives rise to regenerative kinematic-dynamo action. (auth)

1087 DYNAMIC MODEL OF SOLAR FLARES. Strauss, Federico M. Boston, Boston Univ. (1972). 140p. University Microfilms Order No. 72-25,339.

Thesis.

A theoretical study of the time development of the sources of x rays, microwave bursts, and chromospheric radiation of solar flares is formulated and compared with observations. The specific model adopted for the geometry of the flaring region is due to Sturrock. (TSS) (Diss. Abstr. Int., B)

1088 SIGNAL-TO-ENERGY CONVERSION FUNCTION IN THE PHOTOMETRY OF SOLAR SOFT X RADIATION WITH BROAD-BAND DETECTORS. Lefus, V. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 223-31(1972).

The paper describes the method of determining the function which defines the conversion of a signal, observed by a broad-band X-ray detector, to the incident energy flux. An exact solution can only be obtained if the spectral distribution of the x-radiation is known. As an example, the conversion function with two ionization chambers has been investigated in the 0–8 Å and 8–12 Å ranges; the chambers were installed in the SOLRAD 8 satellite. Theoretical spectra of the coronal plasma for a model of a homogeneous isothermic source were used. The solution allows for the determining of the effective limits of the wave-band efficiency of the detector. Under these conditions, the variation of the conversion function with the shape of the spectrum is minimum, so that the signal-to-energy conversion does not require the spectral energy distribution to be known accurately. The inaccuracy in determining the chemical composition of the coronal plasma has no substantial effect on determining the conversion function. The spectral sensitivity ranges given and the constant conversion factors used, derived for the spectral distribution of a grey body, are only of a conventional nature with regards to the ionization chambers investigated. (auth)

1089 GRAPHICAL METHOD OF STUDYING THE DISTRIBUTION OF THE MACROSTRUCTURE OF SOLAR ACTIVITY. Ambroz, P. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 232-7(1972).

The paper describes a photographic method which can be used for processing two-dimensional images in which it is necessary to suppress minor and sporadically occurring regions but, on the contrary, to stress extensive formations. The paper has been divided into two parts. In the first, a method of graphical surface integration is described, which makes use of optical transformation in processing the original image by an unfocussed camera. In the second part, the method of processing the transformed image by means of the photographic isodensitometry is illustrated. The method is applicable in general. Its application to the study of the macrostructural density of the distribution of Ca II flocculae on the solar surface is demonstrated. (auth)

1090 LIST OF OBSERVATIONS OF THE YELLOW CORONAL LINE MADE AT LOMNICKY STIT. Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 238(1972).

The paper gives a list of all observations of the yellow coronal line made at Lomnický Štit between 1966 and 1970. (auth)

1091 REDUCTION OF THE INTENSITIES OF THE 530 A AND 6374 A LINES OBSERVED AT LOMNICKY STIT TO A NEW SCALE. Rybansky, M. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 23: No. 4, 239-41(1972).

The paper describes the method of reducing the intensities of the 5303 Å and 6374 Å coronal lines, observed during the period 1965–1970, to a new scale used at Lomnický Štit since 1 January 1971. (auth)

1092 WHAT COOKS WITH SOLAR NEUTRINOS. Fowler, William A. (California Inst. of Tech., Pasadena). Nature (London); 238: No. 5358, 24-5(7 Jul 1972).

Two desperate explanations of the solar neutrino puzzle are proposed, one involving experimental nuclear physics and the other theoretical solar structure and evolution. (auth)

1093 SPECTRA OF SOLAR FLARES. Svestka, Zdenek (ESTEC, Noordwijk, Netherlands). Annu. Rev. Astron. Astrophys.; 10: 1-24(1972).

Solar flares emit radiation within a very broad range of wavelengths 2×10^{-10} cm up to more than 6×10^{4} cm. Only the flare spectrum in the region accessible to ground-based optical solar spectrographs is discussed, while other parts of the spectrum are mentioned only if necessary for an understanding of the optical observations. (W.D.M.)

1094 SOLAR NEUTRINOS. Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Sears, R. L. Annu. Rev. Astron. Astrophys.; 10: 25-44(1972).

The various methods of detection of solar neutrinos that have been proposed, and their sensitivity to the different sources of solar neutrinos, are described; particular emphasis is placed on the ^{37}Cl experiment that has been performed by the Brookhaven group. The results of detailed solar model calculations are described and the straightforward inferences that follow from a comparison of calculation and observations are listed. (W.D.M.)

1095 SOLAR SPICULES. Beckers, Jacques M. (Air Force Cambridge Research Labs., Sunspot, N. Mex.). Annu. Rev. Astron. Astrophys.; 10: 73-100(1972).

This review updates those by Thomas and Athay 1961, Pagel 1964, Beckers 1968, and Giovanelli 1967b by including the observational and derived results from recent observations in the optical, far ultraviolet, and radio regions of the solar spectrum. The principal developments are (a) in the understanding of the appearance of spicules as seen on the disk, (b) in the first, still indirect, information derived from ultraviolet data, and (c) in the theoretical concept that spicules may be secondary phenomena resulting from the heat conduction backward from the corona. (W.D.M.)

1096 RADIO BURSTS FROM THE SOLAR CORONA. Wild, J. P.; Smerd, S. F. (CSIRO, Sydney). Annu. Rev. Astron. Astrophys.; 10: 159-96(1972).

This review was intended to update the article Solar Bursts by Wild, Swerd, and Weiss (1963) which appeared in this series. Attention is concentrated on the radio emission from traveling disturbances in the corona—Type III, Type II, and moving Type IV bursts—and the role they play in the flare phenomenon. Considerable progress has been made in the understanding of these bursts during the past decade, owing to the introduction of interplanetary and new forms of ground-based observations, and to developments in plasma theory. (W.D.M.)

1097 HISTORY OF THE EARTH. THE PRESIDENTIAL ADDRESS. Hoyle, F. (Cambridge Univ., Eng.). Quart. J. Roy. Astron. Soc.; 13: No. 3. 328-45(Sep 1972).

Two problems were discussed: the formation of the Earth as part of the solar system; and the implications of the variation of the gravitational constant with time. Under the first head, the conditions for rotational instability of the primaeval Sun were considered in the light of present knowledge of the chemical composition of the planets, their masses, densities, and distances, and the probable amount of material that was lost to outer space. The mechanism by which the primaeval planetary materials segregated as they moved away from the Sun was next discussed. It was suggested that the iron core of the Earth was condensed first, that the rock-forming materials were added later, and that the volatiles were swept up by the Earth in its orbit from condensed matter ejected by the great planets Uranus and Neptune. In the second part of the discussion, the evidence for a slowly weakening gravity was examined. The implications for the development of life on the Earth of a higher solar constant at the time of origin of the Earth were considered; it was suggested that the average temperature on the Earth fell from about 100°C to its present value of about 10°C and that the maximum fossil ages of various forms of life, from bacteria, through blue-green algae and so on, to animals, including protozoa, are in accord with the theory. Finally, the implications of a decreasing G for an expanding Earth were considered. It was suggested that heated material from appreciable depths within the Earth reaches the surface along cracks and rifts in the crust, to increase the surface area. The energy released by radioactivity could maintain plate movement and continental drift through dynamical instability to meet the need for surface expansion. (UK)

1098 POSSIBLE DEPENDENCE OF DIFFERENTIAL SHIFTS OF FRAUHOFER TELLURIUM LINES ON THE SUN'S ZENITH DISTANCE. Mel'nikov, O. A.; Salman-Zade, R. Kh.; Solonskii, Yu. A.; Khilov, E. D. (Leningrad State Univ.). Dokl. Akad. Nauk SSSR; 205: No. 5, 1054-6(11 Aug 1972). (In Russian).

Tellurium lines have commonly been utilized in a determination of differential shifts of Fraunhofer lines in the solar spectrum because it was believed that their position did not alter with the time of observation. A study was made of the "immobility" of the Te lines as reference data points, and the results indicated a dependence of the shifts of Te lines on the time of the observations. (K.S.W.)

1099 COMPARISON OF THE HARD SOLAR X-RAY BURST OF FEBRUARY 11, 1970 OBSERVED AT BALLOON AND SATELLITE ALTITUDES. Ogura, K. (Nihon Univ., Narashino, Japan); Frost, K. J.; Kodama, M. pp 432-6 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

On February 11, 1970 energetic solar x rays were observed simultaneously by a balloon in Antarctica and the OSO-5 satellite with comparable instruments measuring x rays above 15 keV. In the rising phase of the x-ray burst the time constant was found to be almost the same in both observations, with respect to their corresponding energy channels. A far longer decay time constant was obtained from satellite recordings below 2 keV. The energy spectrum measured at a balloon altitude of 7 g/cm^2 was found to reflect faithfully the spectrum in interplanetary space for the higher-energy range above 100 keV, but was very much steeper in the lower-energy region. Such excess counts of photons amounted to ~400% and ~200% for energies of ~40 keV and ~70 keV, respectively. It is suggested that this excess flux may be explained by the contribution of the Compton scattered photons into the omnidirectional balloon-borne detector. (auth)

1100 OBSERVATIONS OF THE SCATTER-FREE SOLAR-FLARE ELECTRONS IN THE ENERGY RANGE 20 TO 1000 keV. Wang, J. R. (Goddard Space Flight Center, Greenbelt, Md.); Fisk, L. A.; Lin, R. P. pp 438-43 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Observations of the scatter-free electron events from solar active region McMath No. 8905 are presented. The measurements were made from Univ. of California Solar Particle Experiment and Goddard Space Flight Center Cosmic-Ray Experiment on IMP-IV satellite. The data show that more than 80% of the electrons from these events undergo no or little scattering and that these electrons travel only ~1.5 AU between the Sun and the Earth. The duration of these events cannot be accounted fully by velocity dispersion alone. It is suggested that these electrons could be continuously injected into interplanetary medium for a time interval of ~2 to 3 minutes. Energy spectra of these electrons which should represent the spectra near the flare site are discussed. (auth)

1101 COMPOSITION AND SPECTRUM OF PARTICLES WITH 0.2 ≤ 30 MeV/nuc IN THE 25 JANUARY 1971 SOLAR FLARE. Price, P. B.; Sullivan, James D. (Univ. of California, Berkeley). pp 449-54 of twelfth International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From twelfth international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 2).

Tracks of ~500 solar particles with $Z \gtrsim 14$ and ~150 particles with $Z \cong 8$ were analyzed in a stack of plastic detectors exposed in a rocket during the January 25, 1971 flare. The energy spectra peak at ~1.5 MeV/N, with the flux falling to zero at ~0.4 MeV/N. Fe, Si, and O appear to have similar energy spectra. Tentative abundances relative to Si with $2 \leq E \leq 5$ MeV/N are: $O \sim 10$ to 40; Si ≡ 1.0; S < 0.25; Ar < 0.15; Ca < 0.2; Ti < 0.3; Cr < 0.4; Fe ≅ 1.8; Ni to Zn ≅ 0.05. Fe/Si is consistent with the revised high-Fe photospheric abundance. S/Si appears significantly below the photospheric ratio. (auth)

1102 CHARGE COMPOSITION OF SOLAR COSMIC RAYS. Bertsch, D. L.; Fichtel, C. E.; Reames, D. V. (Goddard Space Flight Center, Greenbelt, Md.). pp 455-60 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The composition of energetic solar particles is reviewed for all solar events in which measurements on helium and heavier nuclei have been made simultaneously in the same detector during a given particle event. For nuclei of equal charge-to-mass ratio, the relative abundances have been the same within uncertainties in every measurement, and consistent with spectroscopic photospheric estimates. Iron has a slightly different charge-to-mass ratio but is still of considerable interest. An observation of the Fe/O in the January 24, 1971 solar event has provided a second determination of this value. (auth)

1103 SEARCH FOR NEUTRONS OF SOLAR ORIGIN USING BALLOON BORNE DETECTORS. Eyles, C. J.; Linney, A. D.; Rochester, G. K. (Imperial Coll. of Science and Tech., London). pp 462-7 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A series of telescopes having approximately a 30° half opening angle and responding to neutrons in the energy range 50 to 350 MeV have been flown to the top of the atmosphere on balloons released from an equatorial launching site. An upper limit of the order of 30 neutrons m^{-2} sec^{-1} at the Earth has been placed on the continuous solar neutron flux, and a limit of 4 photons m^{-2} sec^{-1} has also been placed on the corresponding gamma-ray flux in the energy range above 20 MeV. Limits have likewise been placed on the total emission from various flares. The neutron albedo has been measured to be 0.35 ± 0.10 neutrons m^{-2} sec^{-1} MeV^{-1} at approximately 100 MeV. (auth)

1104 STORAGE OF ENERGETIC PARTICLES IN THE SOLAR ATMOSPHERE. Ahluwalia, H. S. (Univ. of New Mexico, Albuquerque). pp 468-73 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The problem of storing energetic protons with energies from 0.5 to 100 MeV at different depths in the solar corona was examined. The calculations were based on an empirical model of the electron density, temperature, and the magnetic field over coronal active regions. It was found that the magnetic field lines must be blown open at altitudes of about one solar radius above the photosphere. Upper limits were derived to the times of survival of protons, as a function of their kinetic energy, on the assumption that the solar corona consists of completely ionized hydrogen and that the protons lose energy only by ionization. The results were compared with the observations of energetic storm particle events. It was concluded that high-energy protons (≳100 MeV) may be stored quite close to the photosphere. These protons may occasionally be released into the interplanetary medium either directly or perhaps by leakage from Schatten's magnetic bottle. However, low-energy protons (≲3 MeV) must be continuously replenished by the Sun in the outer corona from where they propagate to the Earth's orbit as suggested elsewhere (Ahluwalia, 1969). (auth)

1105 CALCULATIONS OF THE SEASONAL DEPENDENCY OF NEUTRON MONITORS TO AN ANISOTROPIC FLUX OF SOLAR COSMIC RAYS PROPAGATING IN THE ECLIPTIC PLANE. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). pp 475-80 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Using a mathematical model of the magnetosphere which includes the internal magnetic field and external sources, the viewing directions for various high latitude neutron monitor stations were calculated as a function of local time and their relative response to two different solar cosmic-ray anisotropies propagating along the ecliptic plane for the March and September equinox was evaluated. The evaluation of the response of these stations as a function of the season showed daily and seasonal effects both of which are significant in evaluating the absolute value of the interplanetary flux. (auth)

1106 DETERMINATION OF THE SPECTRA, SPATIAL ANISOTROPY, AND PROPAGATION CHARACTERISTICS OF THE RELATIVISTIC SOLAR COSMIC-RAY FLUX ON NOVEMBER 18, 1968. Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.); Shea, M. A.; Tanskanen, P. J. pp 483-8 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 2).

An analysis of the response of neutron monitors to the November 18, 1968 solar cosmic-ray event was performed to deduce the propagation characteristics of relativistic solar cosmic rays in the interplanetary medium. Using a mathematical model of the magnetosphere to calculate the asymptotic directions of approach for each station as a function of the time of the particle increase (1100 UT) it was possible to select a unique combination of source direction, particle anisotropy, and spectrum which reproduced the responses of the ground-level neutron monitors. From this analysis it is shown that the particles had a Gaussian distribution along the interplanetary magnetic field direction. Repeated evaluation of the product of the particle spectrum, neutron monitor yield function, and particle anisotropy, allowing for a slight decrease in the anisotropy as the event progresses, provides for a mathematical simulation of the response of each station as a function of time throughout this event. (auth)

1107 TRANSPORT OF SOLAR FLARE PROTONS: COMPARISON OF A NEW ANALYTIC MODEL WITH SPACECRAFT MEASUREMENTS. Lupton, J. E.; Stone, E. C. (California Inst. of Tech., Pasadena). pp 492-7 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

An analytic solution has now been obtained to the complete Fokker–Planck equation including the effects of convection, interplanetary deceleration and acceleration, corotation, and anisotropic diffusion with $\kappa_{||}$ constant and with $\kappa_{\perp} \propto r^2$. With the boundary of the diffusing region at 2.3 AU, a solar-wind velocity of 400 km sec^{-1}, $\kappa_{||} \sim 7 \times 10^{20}$ cm^2 sec^{-1}, and impulsive injection on the line of force connecting to the Earth, the solution yields a time to maximum for the particle flux of ~10 h and an exponential decay time of ~25 h. Several solar-flare particle events have been observed with the Caltech Solar and Galactic Cosmic Ray Experiment on OGO-6. Detailed comparisons of the calculated time dependence of the fluxes with these observations of 1 to 70-MeV protons show that the model adequately describes both the rise and decay times, indicating that $\kappa_{||}$ = constant is a better representation of conditions inside 1 AU than is $\kappa_{||} \propto r$. (auth)

1108 PROPAGATION OF SOLAR COSMIC RAYS. Ng, C. K.; Gleeson, L. J. (Monash Univ., Clayton, Australia). pp 498-503 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A theoretical model has been developed for the propagation of cosmic rays emitted impulsively from the Sun. The model includes the effects of convection, energy loss due to adiabatic deceleration and diffusion solely along the interplanetary magnetic field. The properties and speed of propagation of the particle distribution have been studied for a number of diffusion coefficients each independent of energy, and for a range of boundary and initial conditions. Particular attention has been paid to the decay phase and the late time anisotropy. (auth)

1109 ENERGY CHANGE OF SOLAR COSMIC-RAY PARTICLES. Urch, I. H.; Gleeson, L. J. (Monash Univ., Clayton, Australia). pp 504-9 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Numerical solutions of the steady-state cosmic-ray equation of transport were obtained to show the redistribution in kinetic energy and heliocentric radius of cosmic rays emitted from the Sun with kinetic energy less than 100 MeV/N. (auth)

1110 CONVECTION-DOMINATED TRANSPORT OF SOLAR COSMIC RAYS. Forman, Miriam A. (State Univ. of New York, Stony Brook). pp 511-13 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

An analytic solution for the exponential decay phase of low-energy solar particle events was examined to determine (1) why the maximum intensity is at a distance $L' \sim 3K/V$ from the free-escape boundary at L, (2) how this causes the decay time to approach $4K/V^2$ for very small K, (3) how the maximum decay time L/2CV makes "knees" in energy spectra move to lower energies slower than the adiabatic deceleration rate, and (4) why the anisotropy (maximum flux) arrives east of the Sun in some events. (auth)

1111 OBSERVATION OF PARTICLE FLUXES OVER EXTENDED SOLAR LONGITUDES DURING THE SOLAR FLARE EVENT OF MARCH 31 TO APRIL 10, 1969. Bukata, R. P. (Univ. of Texas, Dallas); Rao, U. R.; McCracken, K. G.; Keath, E. P. pp 514-18 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

The cosmic-ray flux at different energies during the complex flare events which occurred in the time interval March 31–April 10, 1969 as observed on Pioneers 6 through 9 was examined in great detail to construct the complete time intensity profile in space. The particle injection from the active region approximately 20° behind west-limb resulted in cosmic-ray population becoming apparent over a wide range of heliocentric longitudes. The subsequent evacuation of particles from the solar system is explained on the basis of convective propagation, the cosmic-ray particles experiencing a convective removal controlled by the radially outward moving solar plasma. The effect of the azimuthal density gradient and its energy dependence on the decay-time constant of the intensity time profile was examined at different energies. The significance of the relative position of the observer with respect to the centroid of the population in the determination of the decay time profile with particular reference to the events in question is discussed. (auth)

1112 EVACUATION OF SOLAR COSMIC RAYS FROM THE INTERPLANETARY MEDIUM. Rao, U. R. (Physical Research Lab., Ahmedabad, India); McCracken, K. G.; Bukata, R. P.; Keath, E. P. pp 519-24 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Cosmic-ray observations from Pioneer 6 through 9 situated at different heliocentric longitudes were analyzed to investigate the evacuation of solar cosmic-ray particles after their injection into the interplanetary medium. During initial stages of the decay, it was found that the radial convective removal plays an important part in the evacuation of cosmic-ray flux from the vicinity of the Sun which eventually sets up ($T \geq 4$ days) a positive density gradient in the solar cosmic radiation at the orbit of the Earth. The positive density gradient causes an anisotropy parallel to $\vec{E} \times \vec{B}$ and from a direction of 45°E of the satellite–Sun line. Strong gradients in heliocentric longitude are observed which are essentially invariant with time but are dependent on energy. Such gradients have a major effect on the temporal variation of cosmic-ray flux during the decay phase of flare effect. Evacuation of solar cosmic-rays and the observed decay time constant is either increased or decreased relative to the convective value depending on the position of the observer relative to the centroid of the cosmic-ray population. It is further shown that the exponent of the cosmic-ray spectrum is dependent on the location of the observer relative to the centroid of the cosmic-ray population injected by the parent flare. At a given point in the frame of reference of the cosmic-ray population, the spectral exponent is invariant with time. (auth)

1113 ANISOTROPY CHARACTERISTICS OF LOW ENERGY COSMIC RAY POPULATION OF SOLAR ORIGIN. Rao, U. R. (Physical Research Labs., Ahmedabad, India); McCracken, K. G.; Allum, F. R.; (and others). pp 525-30 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Investigation of the anisotropic characteristics of the low-energy solar-flare cosmic-ray particle enhancements (both ionic and electronic) observed by Explorer 34 satellite shows very clearly that there are 3 distinct phases in a flare event. The field-aligned large anisotropy during the rise time of the flare event which immediately after the intensity maximum changes to radial equilibrium anisotropy due to the convective removal of the particles by the solar wind. At late times, the anisotropy is observed to be from a direction approximately 45° east of the satellite–Sun line which is interpreted as indicative of a positive density gradient of solar cosmic-ray population. Both the radial and easterly equilibrium anisotropies observed during the early and late part of the decay are shown to be inversely proportional to the velocity of the particle and directly proportional to the velocity of the solar wind in agreement with the theory. The amplitude of the large field-aligned anisotropy observed during the rise time of the flare event is shown to be completely independent of the rise time of the flare event and seems to vary with time t as $(V_t)^{-1}$, in accordance with Fisk and Axford theory. The effect of the interplanetary sector structure on different anisotropies is examined. It is shown that the interplanetary magnetic sector crossings cause abrupt reversals in the nonequilibrium anisotropy phases resulting in a drastic reduction of the amplitude. On the other hand, the sector crossings do not affect the equilibrium anisotropy characteristics. (auth)

1114 PROPAGATION OF ENERGETIC SOLAR PARTICLES DURING HIGHLY ANISOTROPIC GROUND LEVEL EVENTS. Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). pp 533-7 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

During the current solar cycle, seven ground-level events (GLE) representing the arrival of high-energy solar particles (≥0.5 GeV/N) have been recorded, thus far, by neutron monitors. Among these, the two events on November 18, 1968, and February 25, 1969, respectively, were characterized by a high degree of anisotropy (≥90%). Both display the effects of scattering by small-scale irregularities. The ground-level data recorded during the second event were consistent with the presence of a bidirectional source. Analysis of the data from stations for which

the spread of the directions of viewing at the appropriate local time is small (to insure that the asymptotic cones are essentially invariant with respect to changes in the rigidity spectrum) revealed differences in the intensity--time profiles of these GLE as observed at different stations. These differences are related to the angle between the effective asymptotic directions of viewing and the axis of symmetry (source location). (auth)

1115 MILLISECOND-TIME-SCALE ATMOSPHERIC LIGHT PULSES INDUCED BY SOLAR ACTIVITY. Oegelman, H. (Middle East Technical Univ., Ankara); Fisher, A.; Bertsch, D. pp 805-10 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

A wide-angle photomultiplier system designed to detect fluorescence light emission induced by bursts of energetic photons that may be produced during the early phases of supernovae explosions has been in operation for over two years. During this time a class of fast atmospheric pulsations (FAP) of millisecond time scale has been discovered. The physical extent of the atmosphere involved in this emission is around 100 km. Nights with very high FAP rates appear to be correlated with strong solar activity. It is believed that these events are caused by instabilities associated with particles stored in the magnetosphere. (auth)

1116 ARRIVAL OF SOLAR PROTONS OVER THE POLAR CAPS AND MAGNETOSPHERIC FIELD MODELS. Morfill, G. E.; Quenby, J. J. (Imperial Coll. of Science and Tech., London). pp 818-23 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Trajectory integrations were performed in the Williams and Mead field model (6-term expansion) to find the asymptotic direction appropriate to 30- to 400-MeV solar protons observed over the polar caps during the events of Nov. 18, 1968 and Feb. 25, 1969. Apart from conventional impact-zone effects it is shown that protons moving along interplanetary field lines from the Sun can become attached to magnetotail lines, preserving the distribution function and then approach the Earth. Some previously quoted examples of "delayed entry" into the tail or "magnetospheric screening" may be due instead to interplanetary anisotropy. (auth)

Galaxies

1117 COMPARISON OF SPECTRAL SCANS OF SOME E AND S0 GALAXIES. Spinrad, Hyron (Univ. of California, Berkeley). Astrophys. J.; 177: No. 2, 285-9(15 Oct 1972).

Scans of the nuclear regions of four E and S0 galaxies covering a luminosity range of about 5 mag are presented. They confirm and extend the trends of increasing blueness and decreasing metal-line strength with decreasing luminosity anticipated from existing broad- and intermediate-band photometry. NGC 205 has very strong Balmer absorption lines. An attempt at a stellar population synthesis for the center of NGC 3379 is presented to illustrate the difficulty encountered by the simultaneous presence of strong metallic absorption lines with a relatively blue continuum produced by hotter stars. (auth)

1118 HIGH-FREQUENCY STUDY OF CYGNUS A. Yip, Ka Bing W.; Seielstad, G. A. (California Inst. of Tech., Pasadena). Astrophys. J.; 177: No. 2, 291-301(15 Oct 1972).

Measurements at 8300 and 9600 MHz were combined to map the distribution of total radiation across Cygnus A with a beam of half-power width ~20″ EW × 30″ NS. Steep brightness contours were noted on the outer edges and more gradual inner extensions toward the optical galaxy. The brightest peaks within each radio component have flatter spectra than the rest of the source. The distributions of linearly polarized radiation at both 8300 and 9600 MHz were mapped. Nearly everywhere in the source the degree of polarization at 9600 MHz exceeds that at 8300 MHz. The rotation measures vary more or less systematically across Cygnus A from a very large negative value at the following edge to a positive value on the preceding edge. The Sf component of Cygnus A is probably more distant than the Np. Within each component the density of the thermal plasma and the magnetic field strength are greatest at the outer edges. The observations support the suggestion of ram-pressure deceleration of the ratio components by an intergalactic medium. (auth)

1119 IS THE EXISTENCE OF A GALAXY EVIDENCE FOR A BLACK HOLE AT ITS CENTER? Ryan, M. P. Jr. (Univ. of Texas, Austin). Astrophys. J.; 177: No. 2, L79-83(15 Oct 1972).

A Newtonian analysis of a cosmological perturbation with a central black hole is presented. It is shown that a central mass of $\sim 10^7$ $M_\odot$ would have caused this Galaxy to accrete from a small initial perturbation. (auth)

1120 PHOTON REST MASS AND MAGNETIC FIELDS IN THE GALAXY. Byrne, J. C.; Burman, R. R. (Western Australia Univ., Nedlands). J. Phys., A (London); 5: No. 10, L109-11(Oct 1972).

The effect of a photon rest mass on the dissipation of magnetic fields in the Galaxy is discussed and an upper limit on the rest mass is obtained: an earlier treatment is corrected and refined. (auth)

1121 PHOTON REST MASS AND THE ABSORPTION OF LONGITUDINAL ELECTRIC WAVES IN INTERSTELLAR SPACE. Burman, R. (Western Australia Univ., Nedlands). J. Phys., A (London); 5: No. 8, L78-80(Aug 1972).

The absorption of longitudinal electric waves in a cold plasma is discussed; upper limits for absorption in propagation from the galactic center to the Earth are estimated. (auth)

1122 NEBULAE OF THE SOUTHERN MILKY WAY. AN ATLAS. Lynga, G.; Hansson, N. (Lund Observatory, Sweden). Astron. Astrophys., Suppl. Ser.; 6: No. 4, 327-414(Aug 1972).

An atlas of the Southern Milky Way in wavelengths around H_α is presented together with a catalog of identified stars, nebulae, and open clusters. (auth)

1123 HEATING AND IONIZATION OF H I REGIONS. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass.); McCray, R. A. Annu. Rev. Astron. Astrophys.; 10: 375-426 (1972).

Cooling mechanisms for H I regions are discussed, including for the sake of completeness a discussion of the cooling of high-temperature H II regions and dust clouds. The kinetic theory of heating and ionization by cosmic rays and x rays is presented. Observations of H I regions are described and the energy source problem of the interstellar gas is discussed in view of the observations and the cooling rates, paying particular attention to the role of supernovae. Steady-state models of the interstellar medium are reviewed, the validity of the steady-state assumption is examined, and time-dependent models for the structure of the interstellar medium are considered. (W.D.M.)

Cosmology

Refer also to abstracts 986, 1097, 1431, and 1437.

1124 ORIGIN OF ASTROPHYSICAL MAGNETIC FIELDS (TURBULENT "DYNAMO" MECHANISMS). Vainshtein, S. I.; Zel'dovich, Ya. B. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Usp. Fiz. Nauk; 106: No. 3, 431-57(Mar 1972). (In Russian).

Normal (large-scale) magnetic fields and chaotic (very small-scale) magnetic fields are the subject for this review. The origin of "bare" magnetic fields, the symmetrical (two-dimensional) problem following the work of Zel'dovich, and the generation of a normal field of hypotropic turbulence are outlined. Astrophysical examples such as the value of α, and the limiting conditions of the problem of diamagnetism of a turbulent liquid are outlined. The "chaotic" aspect of the subject deals chiefly with turbulence problems and precise solutions for some models of turbulence, and the "turbulent dynamo" in the presence of acoustic turbulence and vortex excitation. The nonlinear problem and the steady-state field section focusses attention on magnetic gyrotropic phenomena and their properties. (66 references) (K.S.W.)

1125 SOME PROPERTIES OF COSMOLOGICAL MODELS. Novikov, S. P. (Inst of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 6, 1977-89(Jun 1972). (In Russian).

It is shown that in homogeneous cosmological models the Einstein equations can be reduced, on basis of scale invariance, to systems with friction. The formalism involving friction permits one to investigate the problem of isotropization of the solutions in the Bianchi model IX at late development stages. The possibility of a statistical description of the properties of the model is discussed. (auth)

1126 SOME DISTRIBUTIONS OF CHARGED FLUID IN GENERAL RELATIVITY. De, U. K. (Jadavpur Univ., Calcutta). Indian J. Phys.; 45: No. 11, 487-93(Nov 1971).

Some exact solutions of the Einstein–Maxwell field equations corresponding to electrically charged fluid are presented. (auth)

1127 INTERNATIONAL CONFERENCE ON GRAVITATION AND RELATIVITY, COPENHAGEN, DENMARK, JULY 5, 1971. Gen. Relativity Gravitation; 3: No. 2, 63-165(Jun 1972). (CONF-710731).

Separate abstracts were prepared for the eight papers presented. (W.D.M.)

For abstracts of individual papers see: 1128–1135.

1128 ADVANCES IN GRAVITATIONAL RADIATION DETECTION. Weber, J. (Univ. of Maryland, College Park). Gen. Relativity Gravitation; 3: No. 1, 59-62(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

New experiments are reported which improve estimates of the bandwidth and energy flux of the observed radiation. These include search for coincident, sudden increases in power of newly instrumented detectors at 1661 Hz and 1581 Hz, at opposite ends of a 1000 kilometer baseline, and search for coincidences between outputs of detectors at 1661 Hz and 5000 Hz. Coincidences are observed for the detectors separated by 80 Hz, implying a radiation bandwidth exceeding 80 Hz. The new instrumentation is a modification of the earlier technique for bonding ferroelectric crystals to aluminum cylinders. Progress was made in data retrieval employing a computer and magnetic tape. Earlier results on the coincidence rates and time-delay experiments have been confirmed. A 1661 Hz detector was developed for operation at liquid helium temperatures. An experiment was approved by NASA to employ the Moon as a gravitational radiation detector. (auth)

1129 GRAVITATIONAL COLLAPSE AND RELATED PHENOMENA FROM AN EMPIRICAL POINT OF VIEW OR BLACK HOLES ARE WHERE YOU FIND THEM. Peebles, P. J. E. (Princeton Univ., N. J.). Gen. Relativity Gravitation; 3: No. 1, 63-82(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

The formation of pulsars, X-ray stars, and neutron stars by gravitational collapse is discussed, and it is suggested that suitable places for the discovery of black holes would be close binary systems, globular clusters, galactic nuclei, elliptical galaxies, and Seyfert galaxies. (UK)

1130 IMPROVED DETECTOR OF GRAVITATIONAL RADIATION. Aplin, P. S. (Univ. of Bristol, Eng.). Gen. Relativity Gravitation; 3: No. 2, 111-13(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

A detector of gravitational radiation is described, based on that of Weber but having enhanced time resolution. (auth)

1131 LORENTZIAN SYMMETRIC SPACES. Cahen, M. (Univ., Brussels). Gen. Relativity Gravitation; 3: No. 2, 115-17(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

The propositions that (a) there is a 1 to 1 correspondence between the isomorphism classes of pseudo-Riemannian symmetric quadruple spaces and the isomorphism of pseudo-Riemannian symmetric spaces, and (b) a pseudo-Riemannian symmetric space is decomposable (in the usual sense) if, and only if, the associated symmetric quadruple is decomposable are considered. (UK)

1132 GRAVITATIONAL COLLAPSE, WHITE HOLES, AND PARTICLE CREATION. Zel'dovich, Ya. B.; Novikov, I. D. Gen. Relativity Gravitation; 3: No. 2, 119-20(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

Recent advances in the outside picture of a collapsed body, inescapability of singularity in collapse, the identification of black holes in the Galaxy and outside, and white holes are given. (UK)

1133 WEAK-FIELD APPROXIMATION AND THE RANGE OF GRAVITATIONAL FORCE. Layzer, D.; Burke, J. R. (Harvard Coll. Observatory, Cambridge, Mass.). Gen. Relativity Gravitation; 3: No. 2, 121(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

The dynamics of a statistically homogeneous and isotropic universe with weak local gravitational fields are considered. It is shown that fluctuations whose wavelengths are comparable to or greater than the radius of the visible Universe do not in fact grow — in agreement with the intuitive idea that coherent gravitational effects cannot occur over distances greater than $c\tau$ where τ is the time elapsed since the beginning of expansion. Explicit solutions are obtained for all modes in the limit of zero pressure. Finally, the problem of coordinate conditions is treated in a general way. (auth)

1134 PRESENT STATUS OF THE THEORY OF THE RELATIVITY-GYROSCOPE EXPERIMENT. O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Gen. Relativity Gravitation; 3: No. 2, 123-33(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

It is proposed to launch a satellite containing two pairs of gyroscopes into a polar orbit around the Earth. The spin of one pair will be parallel to the Earth's axis and the spin of the other pair will be perpendicular to the plane of the orbit. An expression for the precession of a gyroscope in Einstein theory is given with a detailed discussion of the various perturbations which must be taken into account. A general formulation incorporating the predictions of other gravitational theories is proposed, as well as the merits of other orbits. (UK)

1135 RECENT DEVELOPMENTS IN THE THEORY OF GRAVITATIONAL RADIATION. Sciama, D. W. (Oxford Univ.). Gen. Relativity Gravitation; 3: No. 2, 149-65(Jun 1972).

From International conference on gravitation and relativity; Copenhagen, Denmark (5 Jul 1971). See CONF-710731.

A review is given of recent developments in the emission of gravitational radiation including gravitational radiation damping, gravitational radiation and the final state of a collapsing system and the upper limits of radiation efficiencies; the propagation and absorption of gravitational radiation and the use of the latter in the detection of gravitational radiation. (UK)

1136 METRIC OF AN ASTRONOMICAL OBJECT IN THE LYTTLETON–BONDI THEORY. Burman, R. (Univ. of Western Australia, Nedlands). J. Proc. Roy. Soc. N. S. W.; 104: Pt. 1-2, 1-4(1971).

Lyttleton and Bondi developed a cosmological model in which there is net imbalance of charge, with matter and hence charge being continuously created. The equations of that theory, namely the Proca equations combined with Einstein's field equations of general relativity, are used to investigate the space–time outside a static spherically symmetric object, with a radial outflow sufficient to keep the matter and charge densities constant. The situation with zero electromagnetic fields but non-zero potentials is investigated. An expansion of the metric is obtained which shows that there is no detectable departure from the predictions of the Schwarzschild metric. (auth)

1137 JOINING OF TWO SEMICLOSED WORLDS AND A COSMOLOGICAL MODEL OF MATTER-ANTIMATTER ASYMMETRY. Hokkyo, Noboru (Hitachi Atomic Energy Research Lab., Kawasaki, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 1, 104-9(Jul 1972).

It is pointed out that the solutions of general relativity field equations allow a model of the closed Universe in which two semiclosed worlds, one filled with the dust of ordinary matter and the other filled with the dust of antimatter, are joined through a narrow Schwarzschild throat. The two semiclosed worlds do not exchange matter in a finite world time but are gravitationally connected to form a single closed world possessing zero baryonic charge. To an observer in one of the two worlds (matter world) the other world (antimatter world) appears as a small (possibly microscopically small) central core having opposite baryonic charge. The model is completely symmetric between matter and antimatter, so that the two semiclosed worlds are said to be enclosed into each other. (auth)

1138 UNIVERSE AS A BLACK HOLE. Pathria, R. K. (Univ. of Waterloo, Ont.). Phys. Can.; 28: No. 6, 91-4(1 Sep 1972).

Since 1917, when Einstein applied his general theory of relativity to study the structure of the universe as a whole, cosmologists have wondered if the universe is geometrically closed or open. Neither theory nor observation has been able to settle this question unambiguously. Several authors have nurtured the hope that the universe may after all be a closed, yet unbounded system. This would solve many problems regarding the nature and origin of the universe, and would fit many of the observations of distant sources made at radio, optical, and other wavelengths. A closer look at the problem, however, reveals that the universe may not only be a closed structure (as perceived by its inhabitants at the present epoch) but may also be a black hole, confined to a region of space which cannot expand without limit. Implications of such a possibility are manifold. (auth) (Canada)

1139 ANISOTROPIC COSMOLOGY AND COSMIC STRUCTURE. Chernin, A. D.; Shvarts, A. N. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR; 205: No. 5, 1057-8(11 Aug 1972). (In Russian).

Large-scale homogeneity and isotropy of the universe does not preclude distinct inhomogeneity and anisotropy in the initial phases of cosmic expansion. The evolution involving homogenization and isotropization of the universe is discussed. (K.S.W.)

1140 INTERGALACTIC MATTER. Field, George B. (Univ. of California, Berkeley). Annu. Rev. Astron. Astrophys.; 10: 227-60(1972).

It is not known whether intergalactic matter exists in substantial quantities or not, but if it does, it has important implications for cosmology and for the evolution of galaxies. This review documents the continuing experimental studies of this question, and assesses the significance of recent data. The emphasis differs from the theoretical one in a previous review of intergalactic matter in this series (Gould 1968). (W.D.M.)

1141 SHORT-WAVELENGTH SPECTRUM OF THE MICROWAVE BACKGROUND. Thaddeus, Patrick (Goddard Inst. for Space Studies, New York). Annu. Rev. Astron. Astrophys.; 10: 305-34(1972).

This review deals with recent determinations of the intensity of the microwave background radiation at wavelengths too short for direct observation from the ground, the short-wavelength background being defined as that covering the spectral range from roughly 3 to 0.3 mm. (W.D.M.)

1142 GRAVITATIONAL-WAVE ASTRONOMY. Press, William H.; Thorne, Kip S. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys.; 10: 335-74(1972).

Topics considered include properties of gravitational waves, generation of gravitational waves, astrophysical sources of gravitational waves, gravitational-wave receivers, and the Weber experiment. (W.D.M.)

1143 COSMOLOGICAL DEPENDENCE OF WEAK INTERACTIONS. Novello, M.; Rottelli, P. (International Centre for Theoretical Physics, Trieste, Italy). J. Phys., A (London); 5: No. 10 1488-94(Oct 1972).

A model for the cosmological time dependence of weak interactions is discussed and some experimental tests suggested. (auth)

Planetary Phenomena

1144 ORIGIN OF THE MOON. Anderson, D. L. (California Inst. of Tech., Pasadena). Nature (London); 239: No. 5370, 263-5(29 Sep 1972).

Explanation of the Moon's composition in a model for the condensation of the planets from a cloud of solar composition suggests that the Moon accreted at higher temperatures and lower pressures than the terrestrial planets. This may be explained if the lunar orbit initially had a high inclination. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 336, 923, 1036, and 1810.

1145 (NP-19464) PITCHANGLE DISTRIBUTIONS OF (100 TO 300) keV PROTONS MEASURED BY THE ESRO IB SATELLITE. Report No. 36. Amundsen, R.; Soeraas, F.; Lindalen, H. R.; Aarsnes, K. (Bergen Univ. (Norway). Dept. of Physics). Jul 1971. 27p. Dep. NTIS (U. S. Sales Only).

The pitch-angle distribution of 100- to 300-keV protons, in the early morning–late afternoon local magnetic time sector, was studied by using data from the early life time of the ESRO IB (Boreas) satellite. The pitch-angle distribution is described as a function of invariant latitude for different geomagnetic activity levels. On the night side, going polewards, the particle fluxes were found to peak at 90°, followed by a latitude range with isotropy. On the day side, two precipitation zones were found during slight disturbances, the poleward one showing an isotropic pitch-angle distribution and the equatorward one an anisotropic distribution peaked at 90°. During disturbed conditions the two zones merge and the region of isotropic pitch-angle distribution expands. The particle loss cones were determined and compared with theoretical ones in a realistic field model. (auth)

1146 (NP-19465) HIGH LATITUDE ELECTRON AND PROTON PRECIPITATION AT DIFFERENT LOCAL TIMES AND MAGNETIC ACTIVITY. Report No. 37. Amundsen, R.; Aarsnes, K.; Lindalen, H. R.; Soeraas, F.; Skovli, G. (Bergen Univ. (Norway). Dept. of Physics). Oct 1971. 21p. Dep. NTIS (U. S. Sales Only).

Data are presented from simultaneous satellite measurements of electron and proton precipitation at high latitudes. The data are sampled in different local time sectors and at different geomagnetic activity levels confined within $0_+ \leq K_p \leq 4_-$ permitting a presentation of some characteristic features and modes of behavior of electron and proton precipitation during different conditions. The latitudinal position and displacement of the precipitation zones versus local time and geomagnetic activity are described as well as the relative importance of the two particle species regarding flux values. The energy ranges studied are for protons between 115 and 180 keV and for electrons greater than 40 keV. (auth) (Norway)

1147 TRANSVERSE ION TEMPERATURE IN AN IONOSPHERIC WIND TUNNEL. Fournier, G.; Pigache, D. (ONERA, Chatillon, France). J. Appl. Phys.; 43: No. 11, 4548-53(Nov 1972).

The transverse ion temperature $T_{i\perp}$ of a collisionless plasma stream which simulates the ionospheric plasma has been measured by two independent means: a long cylindrical probe and a collimator-collector device. Results with the long probe provide an experimental verification of the known end-effect theories. Reliable measurements of $T_{i\perp}$ have been performed by these two methods, which are evaluated and compared. $T_{i\perp}$ can be varied by means of a negatively biased grid immersed in the plasma stream, the grid mesh being larger than about three Debye lengths. The achieved values are typical of the ionospheric conditions; $T_{i\perp}$ was the last parameter to be simulated with its actual value in ionospheric wind tunnels. Examples of cylinder wakes in such conditions are given. (auth)

1148 STUDY OF THE EQUATORIAL F_2 REGION IONOSPHERE. Sterling, Donald Lowell. Dallas; Southern Methodist Univ. (1972). 160p. University Microfilms Order No. 72-27,301.

Thesis.

Many observed phenomena of the equatorial F2-region ionosphere, such as (1) the Appleton anomaly, (2) the noon bite-out of ionization, (3) the splitting of the F2 layer into two peaks during a magnetic storm or during a solar eclipse, or (4) the presence of Fe^+ ions have appeared to be unrelated and therefore have not been well understood. It is the aim of this dissertation to correlate these varied physical phenomena in terms of a single physical model. The assumptions used in constructing this model are based on known physical and chemical processes that have been studied in other connections. The model includes the processes involving photoionization, charge exchange, dissociative recombination, electromagnetic drift, diffusion of ionization, and neutral air winds. These processes are combined through a set of simultaneous equations involving the continuity equation and momentum transfer equation for electrons and for O^+, NO^+, O_2^+, and N_2^+ ions. Numerical solution of the equations is obtained in an electromagnetic drift coordinate frame that moves at the drift of the plasma. The calculated results show that the equatorial phenomena can be understood in terms of these few well known processes. The model can be used as a tool to provide concentration for comparisons with satellite observation, for airglow observation, or for checking out a particular aspect of ionospheric theory. It can also be used for utilitarian purposes in the prediction of propagation paths for radio signals through the ionosphere. (Diss. Abstr. Int., B)

1149 PHOTOELECTRON ENERGY DISTRIBUTION AND ITS VARIATION WITH SUNSPOT ACTIVITY IN THE F REGION OF THE IONOSPHERE. Tolpadi, S. K.; Singh, Dinesh; Singh, S. N. (Banaras Hindu Univ., India). Indian J. Pure Appl. Phys.; 10: No. 3, 242-4(Mar 1972).

Energetic photoelectrons are released due to the photoionization of neutral constituents of the upper atmosphere by solar xuv during daytime. By considering ions in ground and various excited states and the loss of energy to the ambient particles by a variety of elastic and inelastic processes, the equilibrium energy distribution of photoelectrons is determined for two heights (160 and 200 km) for CIRA model 2 for 12 h, corresponding to sunspot minimum. The variation of the distribution of photoelectrons with energy is studied by determining the same for CIRA models 5 and 8 for 12 h, corresponding to the average and maximum sunspot activity. It was observed that the nature of the variation of distribution function f(E) with energy for different solar activity conditions remains the same though there is a small change in the magnitude of f(E) for different values of E. (auth)

1150 ANOMALIES AND IRREGULARITIES IN THE MIDLATITUDE INONOSPHERE. Mullaney, Henry Wendell. Boston; Boston Univ. (1972). 187p. University Microfilms Order No. 72-25,311.

Thesis.

The two major variations of the midlatitude nighttime F region from that predicted by basic ionospheric theory are the occurrence of irregularities in electron density and the evening anomaly. The term evening anomaly describes the fact that summer evening values of peak electron density are much higher than predicted. These variations are examined theoretically and experimentally in order to determine their principal causes. The basic physical processes operating in the F region are outlined in Chapter I. A complete description of the ionosphere encompassing all of these processes is mathematically formidable. In Chapter II, those processes neglected in the basic theory that could contribute to the evening anomaly are discussed. In Chapter III, a new method of examining the evening anomaly, the mapping on a worldwide basis of a parameter that is a measure of the intensity of the anomaly, is presented. This study reveals that the declination and poleward divergence of the Earth's magnetic field determine the magnitude of the anomaly. It is shown theoretically that these results can be explained if horizontal neutral winds play an important role in the formation of the evening anomaly. In Chapter V, it is shown that during periods of enhanced scintillations, fluctuations in the intensity of the 6300-Å airglow line are considerably higher than during periods of low scintillation activity. Power frequency spectra of the red line fluctuations indicate a random frequency spectrum for the corresponding density fluctuations in the range 10^{-3} to 10^{-4} Hz, similar to measured scintillation spectra in the range 10^{-2} to 10^{-3} Hz. It is also shown that there is no systematic measurable enhancement in the red line intensity during periods of enhanced scintillations. This sets an upper limit on the magnitude of possible enhanced precipitation, which, although it does not eliminate precipitation as a possible source of the midlatitude irregularities, suggests that this mechanism is unlikely. A study of scintillation index, total electron content, and total magnetic-field intensity on twenty of the most disturbed scintillation days between November 1967 and March 1970 is presented. On two occasions, fluctuations in scintillation index correspond to fluctuations in magnetic-field intensity. It is concluded that midlatitude scintillations are probably a manifestation of compressional waves, either internal gravity or horizontally ducted hydromagnetic waves, propagating through the midlatitude ionosphere. (Diss. Abstr. Int., B)

1151 QUASIMONOCHROMATIC WHISTLER MODE PACKETS OF SLOWLY VARYING AMPLITUDE. Istomin, Ja. N.; Karpman, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-

Wave Propagation, Moscow). Planet. Space Sci.; 20: No. 10, 1790-3(Oct 1972).

A nonlinear interaction between the whistle-mode wave packet and resonant particles is considered. An evolution of the packet's shape is investigated in detail. (auth)

1152 FLUCTUATION OF THE ELECTRON DENSITY IN THE PERIOD OF SCATTERED REFLECTION AT THE MAXIMUM IONIZATION LEVEL IN THE F REGION OF THE IONOSPHERE. Alimov, O. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 15: No. 8, 15-17(1972). (In Russian).

Calculated dispersion and fluctuations in the electron concentration in the F region of the ionosphere are tabulated at monthly intervals for the year 1964 in the region of Dyushambe (Tadzhik Republic). This was a period of scattered reflections in the F region. It was found that electron density fluctuation at the height of ionization was significantly greater than at the level of critical frequencies. (K.S.W.)

1153 QUASI-PERIODIC Pc 1 MICROPULSATION EMISSION. Offen, R. J. (Univ. of Otago, Dunedin, N. Z.). Planet. Space Sci.; 20: No. 10, 1786-7(Oct 1972).

A Pc-1 micropulsation event, recorded shortly after the geomagnetic storm of May 3, 1967, displays a periodicity of spectrographic morphology that is closely analogous to that more commonly exhibited by quasi-periodic vlf emissions. It is suggested that this event is associated with the periodic bunching of the ambient plasma in the geotail, induced by a geotail cavity hydromagnetic eigenoscillation, and its subsequent injection into the closed-field region of the nighttime magnetosphere. (auth)

1154 ATOMIC OXYGEN CONCENTRATION FROM THE [0I] 5577 A LINE EMISSION AT THE AURORAL ZONE LATITUDE. Dandekar, B. S. (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci.; 20: No. 10, 1781-4(Oct 1972).

A number of observations of the altitude profile of the [O I] 5577-A line emission was conducted from midlatitude stations. These observations can be used for determining the altitude dependence of the atomic oxygen concentration at middle latitudes. No published observations, either direct or indirect, are available for the atomic oxygen concentration at high latitudes. In this note such a measurement, the atomic oxygen concentration determined from the measurement of the [O I] 5577-Å emission from a station in the auroral zone, is presented. Such observations should be useful for the study of the latitudinal dependence of the atomic oxygen concentration. (auth)

1155 TYPES OF CURRENT PATTERNS OF WEAK GEOMAGNETIC DISTURBANCES AT THE POLAR CAPS. Pudovkin, M. I.; Troshichev, O. A. (Leningrad State Univ.). Planet. Space Sci.; 20: No. 10, 1773-9(Oct 1972).

On the basis of geomagnetic data of arctic and antarctic observatories sequences of instant current systems of weak geomagnetic disturbances at the polar caps are constructed for some events. The analysis shows that these disturbances may be represented by the two-vortices S_q^P system (DP_2-system type), which is typical in the winter polar cap as well as in the summer one. A close correspondence between variations of the configuration and the intensity of the vortices in both hemispheres is observed at that period. The formation of the electrojets violates this correspondence. The dependence between the disturbance vectors in the evening and the morning sectors of the auroral zone during the periods of DP_2-system existence only and in the presence of the electrojets is examined. (auth)

1156 ANNUAL AND SUB-ANNUAL EFFECTS OF EUV HEATING. 2. COMPARISON WITH DENSITY VARIATIONS. Ching, B. K.; Chiu, Y. T. (Aerospace Corp., El Segundo, Calif.). Planet. Space Sci.; 20: No. 10, 1761-71(Oct 1972).

By a detailed comparison of annual and sub-annual components of euv absorption heat input with those of the Jacchia density models, the importance of euv heating in the annual and sub-annual variations of the upper atmosphere is considered. When all the geometrical effects of euv heat input are taken into account, it is found that a remarkable correspondence exists between properties of each harmonic component of euv heat input and Jacchia model temperature and densities. Equinoctial latitude independence of diurnal averaged annual and sub-annual components of heat input and density is proposed as a test of the significance of the euv heat input. The Jacchia model is found to satisfy this test rigorously. (auth)

1157 ANNUAL AND SUB-ANNUAL EFFECTS OF EUV HEATING. 1. HARMONIC ANALYSIS. Ching, B. K.; Chiu, Y. T. (Aerospace Corp., El Segundo, Calif.). Planet. Space Sci.; 20: No. 10, 1745-59(Oct 1972).

The rate of solar euv heating in the upper atmosphere by photodissociation and photoionization is computed, taking care to include properly the effects of oblique incidence of solar flux, sphericity of the atmosphere, and ellipticity of the Earth's orbit. The time and latitudinal variations of the computed heat function are revealed by numerical Fourier analysis of the heat function into harmonics of the yearly cycle. It is shown that euv absorption contains a "latitude-independent" semiannual component of heating with the "proper phase" to account for the semiannual density variations. Further, the annual component of the heat function predicts the existence of "summer polar" density increases in the northern and southern hemispheres. (auth)

1158 APPLICATION OF LANGMUIR PROBES TO THE MEASUREMENT OF VERY LOW ELECTRON TEMPERATURES. Smith, D. (Univ. of Birmingham, Eng.). Planet. Space Sci.; 20: No. 10, 1717-26(Oct 1972).

A summary is given of some important results obtained from the attempts to measure low electron temperature ($T_e < 1000$ °K) in afterglow plasmas of pure rare gas and rare gas–oxygen mixtures using cylindrical Langmuir probes. The afterglow plasma is a uniquely suitable medium in which to assess the accuracy of probe measurements by virtue of the fact that T_e in the late afterglow is, under appropriate conditions, expected to equal the gas temperature. The results of such measurements indicate that erroneously high estimates of T_e will inevitably be obtained when observable "hysteresis" is associated with the probe current–voltage characteristics and that the absence of hysteresis is a necessary but not sufficient condition for the accurate measurement of T_e. Accurate measurements of T_e were only obtained after thorough cleaning of the probe and the reference electrode, and in the presence of atomic and molecular oxygen "electron temperatures" were always erroneously higher than the gas temperature (≈ 300 °K) by about 200 to 300 °K. It is suggested that the ionospheric implications of these laboratory results are such as to place considerable doubt on the accuracy of ionospheric in situ probe measurements of electron temperatures particularly those low electron temperatures occurring in the lower ionosphere where atomic and molecular oxygen is abundant. The body of evidence indicates the necessity to obtain the current–voltage characteristic for voltage sweeps of opposite senses in order that the accuracy of the data may be assessed. However, if on-board processing of probe data obtained from rocket and satellite-borne probes is essential because of telemetry constrains, the accuracy of the data so obtained is likely to remain in doubt. (auth)

1159 SPECTRAL ANALYSIS OF GEOMAGNETIC VARIATIONS TO STUDY THE TIDAL AND THE STORM MODULATION EFFECTS. Gupta, Jagdish Chandra (Earth Physics Branch, Energy, Mines, and Resources, Ottawa). Planet. Space Sci.; 20: No. 10, 1613-25(Oct 1972).

High-resolution cross-spectrum analysis between the hourly values of the theoretically generated equilibrium gravitational tide and the hourly values of the geomagnetic H component was carried out. For both series, data from 54 stations made during July 1957 to December 1959 and in 15 cases during January 1953 to June 1955 were used. Only those parts of the spectra that correspond to the nearly 27-day recurrence tendency and the nearly 27-day sidereal period of the Moon are discussed. Whereas in the tidal spectrum peaks near 27 and 14 days period are seen, in the magnetic spectrum the first three peaks with periods nearly 27, 14, and 10 days appeared distinctly above the noise level of the spectrum at all the stations; this was not found to be so for other higher harmonics. The frequencies of the peaks seen in the magnetic spectrum are not found to be precise harmonics of the nearly 27-day recurrence tendency. The frequencies of the 27- and 14-day peaks seen in the magnetic spectrum approximate closely those predicted by the tidal theory during minimum activity period (January 1953 to June 1955). The effect of the increased activity not only increases the amplitudes of both peaks but is found to change their frequencies considerably as well. (auth)

1160 POSSIBLE METHOD FOR ESTIMATING ANY INDIRECT PROCESS IN THE PRODUCTION OF THE $O(^1S)$ ATOMS IN AURORA. Brekke, Asgeir; Pettersen, Helge (Auroral Observatory, Tromsoe, Norway). Planet. Space Sci.; 20: No. 10, 1569-76(Oct 1972).

From the observations of pulsating aurora at Tromsø during the winter 1970/71, it is shown that by using the relationship between I(5577) and I(4278) proposed by Ohmolt (Geofys. Publ. No. 1 (1959)), the resulting effective lifetime of the $O(^1S)$ atoms is a factor of 1.4 too great. Secondly, for 62% of the number of records investigated, indications are found that an indirect mechanism is involved in the production of the $O(^1S)$ atoms. The decay time for this process varies between 1 and 20 sec. A discussion of rele-

vant ionospheric models shows that this process can be dissociative recombination of the O_2^+ ions. (auth)

1161 NOCTURNAL AND SEMIANNUAL VARIATIONS OF THE INTENSITY OF 5577 A EMISSION OF ATOMIC OXYGEN. Pal, S. R.; Shah, G. M. (Atmospheric Environment Service, Downsview, Ont.). Can. J. Phys.; 50: No. 14, 1623-9(15 Jul 1972).

The observed features of 5577-Å emission in night glow at Mt. Abu (India) are presented. The midnight maximum of 5577-Å emission is associated with the large scale circulations in the lower thermosphere. The seasonal variation of this emission is discussed in relation with the semiannual variation in the thermospheric heating. (auth) (Canada)

Effects of Nuclear Detonations

1162 ATMOSPHERIC ELECTRICAL EFFECTS OF NUCLEAR EXPLOSIONS. Holzer, R. E. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 30, 5845-55(20 Oct 1972).

A series of electrostatic field measurements were made in the vicinity of nuclear explosions on the Nevada Proving Ground of the Atomic Energy Commission in 1952. Detonations with energy yields in the 20-kT range produced electric dipoles with the negative charge uppermost and with moments of a few coulomb kilometers. The electrical field produced by the nuclear cloud could be observed for several minutes after the explosion while the cloud moved upward through the troposphere to the vicinity of the tropopause. The estimated magnitude of the dipole moment of the cloud increased for several minutes as it moved upward. The results of the tests are in qualitative agreement with a γ-ray–Compton electron model of charge separation. Difficulties associated with quantitative predictions of the model are discussed. The passage over the instruments of a weakly radioactive cloud from the stem of the mushroom cloud in one test produced results that are interpreted as a perturbation of the normal air–Earth current system. (auth)

Particle Kinetics and Trapping

1163 (AD-740610) HYDROMAGNETIC-WAVE PHENOMENA IN THE MAGNETOSPHERE. Final Report, January 2, 1967–December 31, 1970. Jenkins, A. W. Jr. (North Carolina State Univ., Raleigh). 1 Feb 1971. Contract F19628-67-C-0152. 31p. (AFCRL-72-207). NTIS.

The propagation characteristics for model magnetospheres are compared for hydromagnetic waves in the micropulsations frequency range, $0.0001 \text{ rad/sec} < \omega < 1.0 \text{ rad/sec}$. One model is of a plane, layered medium over a plane, conducting Earth. A second model is one composed of concentric cylindrical shells of plasma surrounding a conducting, cylindrical Earth. In the plane model the magnetic field is horizontal, but varies with height. In the second, the magnetic field is parallel to the cylindrical axis, but again varies with height. The transmission coefficient for the amplitude of the magnetic field of an incident plane hydromagnetic wave is computed as a function of frequency for both models, and the results are compared. The scattering and diffraction effects present in the model with curved surfaces substantially reduce the transmission coefficient at higher frequencies. (auth) (GRA)

1164 (LA-DC-72-1165) SUBSTORM PHENOMENA IN THE DISTANT MAGNETOSPHERE. Hones, E. W. Jr. (Los Alamos Scientific Lab., N. Mex.). [nd]. 28p. (CONF-720838-1). Dep. NTIS.

From Solar terrestrial relations conference; Calgary, Alberta, Canada (28 Aug 1972).

The substorm-related thinning and thickening of the magnetotail plasma sheet observed by the Vela satellites at $r \approx 18 R_E$ is described and illustrated by examples. Magnetic field measurements made by other satellites at $r \approx 30 R_E$ and at $r \approx 60 R_E$ in the tail indicate that the plasma sheet at those greater distances undergoes the same type of substorm variations, approximately in coincidence with those at $r \approx 18 R_E$. These observations, together with plasma flow measurements made by the Vela satellites, support a substorm model for the plasma sheet in which the traditional substorm "breakup" features observed at the Earth signal the onset of magnetic field-line merging at some distance less than ~15 R_E from the Earth, near the midnight sector of the tail. (auth)

1165 (RLO-2229-T-5-2) STUDY OF MAGNETOSPHERIC SUBSTORMS IN CONJUNCTION WITH THE VELA SATELLITE DATA. Annual Progress Report. Akasofu, S. (Alaska Univ., College. Geophysical Inst.). Sep 1972. Contract AT(45-1)-2229. 22p. Dep. NTIS.

The progress made on the study of the morphology of complex behaviors of the plasma sheet during magnetospheric substorms and their causes is reported. Data are presented on possible outflow from the magnetotail into the magnetosheath during magnetospheric substorms; low energy protons in the plasma sheet; plasma flow in the plasma sheet during magnetospheric substorms; simultaneous observations of magnetospheric substorms by the synchronous satellite ATS-5 and Vela satellites; and the structure of the plasma sheet. The results of the Feb. 1971 airborne auroral expedition to investigate the relation between the onset of the thinning of the plasma sheet and the onset time of substorms are briefly discussed. (J.C.W.)

1166 CONSISTENCY OF FIELDS AND PARTICLE MOTION IN THE SPEISER MODEL OF THE CURRENT SHEET. Eastwood, J. W. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 20: No. 10, 1555-68(Oct 1972).

The consistency between fields and particle motion in the region of the current sheet where the field lines link through the current sheet was investigated. The model considered is based on that of Speiser (J. Geophys. Res., 70: 4219 (1965)). Consistent fields together with the particle trajectories were found for the case where the plasma is cold and noiseless. Proton trajectories and electron trajectories are considered. The cross-tail electric field is shown to depend only on the magnetic field and plasma density; consequently the cross-tail potential depends on the width of the tail and can be much greater than the Alfvén potential (Alfvén, J. Geophys. Res., 73: 4379 (1968)). Finally, it is pointed out that although this model only describes a small region of the tail, it provides a starting point for studying the dynamic interaction of particles and field in the current-sheet geometry. Two obvious effects of this interaction are shown to be thinning of the current sheet and heating of the plasma. (U.K.)

1167 LIGHT ION TROUGH. Taylor, Harry A. Jr. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 20 No. 10, 1593-1605(Oct 1972).

A distinct feature of the ion composition results from OGO-2, -4, and -6 satellites is the light-ion trough, wherein the midlatitude concentrations of H^+ and He^+ decrease sharply with latitude, dropping to levels of 10^3 ions/cm^3 or less near 60° dipole latitude ($L = 4$). In contrast to the "main trough" in electron density, N_e, observed primarily as a nightside phenomenon, the light-ion trough persists during both day and night. For daytime winter hemisphere conditions and for all seasons during night, the midlatitude light-ion concentration decrease is a pronounced feature. In the dayside summer and equinox hemispheres, the rate of light-ion decrease with latitude is comparatively gradual, and the trough boundary is less well defined, particularly for quiet magnetic conditions. In response to magnetic storms, the light-ion trough minimum moves equatorward, and deepens, consistent with earlier evidence of the contraction of the plasmasphere in response to storm-time enhancements in magnetospheric plasma convection. The fact that a pronounced light-ion trough is observed under conditions for which the dominant ion O^+ may exhibit little or no simultaneous decrease appears to explain why earlier studies of the "main trough" in topside distributions of N_e and N_i may, at times, have been inconclusive in relating the total ionization minimum with the mechanism of the plasmapause. In particular, the topside distribution of N_i appears to be the complex resultant of several variables within the ion composition, being governed by the competing processes of chemical production and loss, loss through magnetospheric convection, and large-scale dynamic transport resulting from neutral winds and electric fields. The net result is that, in general, the light ion trough, rather than N_i, provides a more fundamental parameter for examining the structure and behaviour of the plasmapause. (auth)

1168 DIURNAL EFFECTS IN Pc 1 HYDROMAGNETIC WHISTLERS: AN EARLY AFTERNOON SOURCE MODEL. Offen, R. J.; Dowden, R. L. (Univ. of Otago, Dunedin, N. Z.). Planet. Space Sci.; 20: No. 10, 1661-70(Oct 1972).

A definite ordering of Pc 1 hydromagnetic whistler diurnal incidence data exists. This ordering and the other known temporal and spatial characteristics of hydromagnetic whistlers are compatible only if it is assumed that the majority of these events are generated in, and subsequently propagate through, a localized region of the magnetosphere close to 1500 h LT. This localized generation region, when ground-mapped along the geomagnetic field, acts as a secondary source from which these events then propagate, via the F-region ionospheric duct, over the Earth's surface. Computed iso-amplitude contours, based on this model, are pre-

sented. The concomitant computed diurnal incidence distributions, as a function of latitude, agree well with experimental observations. (auth)

1169 DIURNAL, SEASONAL, AND Kp VARIATIONS IN THE POSITION OF THE HIGH LATITUDE ELECTRON TRAPPING BOUNDARY. Page, D. E.; Shaw, M. L. (European Space Research and Tech. Centre, Noordwijk, Netherlands). pp 826-33 of 12th International Conference on Cosmic Rays. Vol. 2. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.2).

Data acquired from the ESRO I/Aurorae polar satellite was used to determine the variation of latitude of the northern high-latitude electron trapping boundary over a period of about 15 months. The position of the boundary was determined for about four thousand crossings, and an attempt was made to determine the significance of any seasonal variations in the position of the boundary. The diurnal variation of the boundary position is shown to be well established. A significant variation with the level of geomagnetic activity was observed indicating that with increasing Kp the boundary moves to higher latitudes during the morning hours and to lower latitudes during the evening. The degree of boundary movement is compared with changes in solar-wind velocity and shape of the magnetosphere and the sense of the movement is shown to be in agreement with magnetic field measurements made at the Earth. There would appear to be a seasonal variation, with the trapping boundary shifting to higher latitudes at the equinoxes as has been suggested by more limited data used by Feldstein. (auth)

Solar Wind Interactions

1170 (N-72-19860) COLLISIONLESS SOLAR-WIND PROTONS: A COMPARISON OF KINETIC AND HYDRODYNAMIC DESCRIPTIONS. Leer, E.; Holzer, T. E. (California Univ., San Diego. Dept. of Applied Physics and Information Science). [1971]. 23p. (NASA-CR-125802). NTIS.

Kinetic and hydrodynamic descriptions of a collisionless solar-wind proton gas are compared. Heat conduction and viscosity are neglected in the hydrodynamic formulation but automatically included in the kinetic formulation. The results of the two models are very nearly the same, indicating that heat conduction and viscosity are not important in the solar-wind proton gas beyond about 0.1 AU. It is concluded that the hydrodynamic equations provide a valid description of the collisionless solar-wind protons, and hence that future models of the quiet solar wind should be based on a hydrodynamic formulation. (STAR)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstracts 97, 104, 816, 1778, 1850, and 1896.

1171 THIRD INTERNATIONAL SYMPOSIUM ON MOLECULAR BEAMS, CANNES, FRANCE, JUNE 29, 1971. Entropie; No. 42, 1-181(1971). (In French and English). (CONF-710629).

Thirty-nine papers were presented at the symposium on molecular beams, June 29, 1971. Abstracts were prepared for twenty-two of the papers for NSA; the remaining papers were out of scope. (J.C.W.)

For abstracts of individual papers see: 1172–1193.

1172 OPTIMIZATION OF SKIMMER GEOMETRIES. Bossel, Ulf. Entropie; No. 42, 12-17(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The design of skimmers was re-examined in view of producing nozzle beams of optimum intensity and collimation. The geometric parameters studied include the skimmer diameter, lip radius, and the skimmer length as well as the internal and external cone angles. Irrespective of the state of rarefaction of the incoming flow, a slender skimmer of sufficient length appears to be most desirable for the attainment of intense beams having almost isentropic properties. (France)

1173 IMPROVEMENT TO THE SUPERSONIC MOLECULAR JET METHOD BY SIMULTANEOUSLY INCREASING THE GENERATING AND RESIDUAL PRESSURES. Campargue, R.; Breton, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Entropie; No. 42, 18-28(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The invasion of the free jet by background molecules diminishes when P_1 (the pressure in the expansion chamber) is decreased, or when the nozzle stagnation pressure, P_0, is increased, even if P_1 is increasing simultaneously. The latter solution is most effective for eliminating the invasion effect and offers a new method for improving the intensity and energy of nozzle beams. This improvement is however limited by the skimmer jet interaction (this effect can be reduced by a careful choice of the geometrical parameters and considerations of effects occurring downstream from the skimmer). In spite of these limitations, it is possible to produce with relatively low pumping speeds (300 liters $\cdot$ sec^{-1} in the first chamber), molecular beams with high Mach numbers ($15 \leq M \leq 20$), high intensities ($3 \cdot 10^{20}$ mol $\cdot$ ster^{-1} sec^{-1}), and intermediate energies (11 eV with $T_0 < 900$°K). (France)

1174 FAST AND INTENSE POTASSIUM ATOMIC BEAM PRODUCED BY AERODYNAMIC ACCELERATION. Koller, U.; Hose, H.; Schugerl, K. (Technische Univ., Hanover). Entropie; No. 42, 39-42(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

A system for producing fast intense atomic potassium beams by aerodynamic acceleration in a free binary jet using helium and argon as carrier gases is described. Measurements were performed for total pressures up to 500 torr. Beam intensities were investigated as a function of the nozzle to skimmer distance, the pressure of the carrier gas, and the nozzle temperature. The radial Mach numbers calculated from the radial intensity profiles lie between 6 and 18. Axial Mach numbers measured using the time-of-flight method lie between 5 and 9.5 (depending on the carrier gas pressure). Aerodynamic acceleration manifests itself in the increase in the most probable velocity of the potassium atoms with increasing pressure of the carrier gas. (France)

1175 PRODUCTION OF A FAST BEAM OF METASTABLE H(2s) ATOMS. Gautherin, G.; Vu Ngoc Tuan (Paris Univ., Orsay, France). Entropie; No. 42, 48-51(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

A beam of metastable hydrogen atoms, H(2s), was produced by charge-exchange collisions between protons and CS vapor: $H^+ + Cs \rightarrow H(2s) + Cs^+ - 0.49$ eV. Protons having energies in the 500 to 3000 eV range are used. The proton beam was made to intersect a beam of Cs vapor in a region where a strong transverse electric field was applied. The Lyman-α radiation subsequently emitted was detected using a uv monochromator positioned above the interaction region. The Lyman-α detector was calibrated from the known cross sections for the production of Lyman-α radiation in $H^+ + He$ and $H_2^+ + He$ collisions measured by Pretzer et al. The σ_{2s}/σ_{2p} ratio was measured for proton–cesium collisions; it was found to be 0.30 at a proton energy of 3000 eV. (France)

1176 PRODUCTION OF HIGH DENSITY MOLECULAR JETS AND EXCITATION OF THE EMISSION SPECTRUM. Aubert, Daniel; Baldy, Andre; Chantrel, Henri (Univ., Aix-Marseille, France). Entropie; No. 42, 60-4(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

An apparatus for high-resolution spectroscopy in the 7000 to 1200-A range is described. The apparatus consists of a spherical or cylindrical multichannel collimator source (enabling molecular jets having intensities exceeding 10^{14} molecules/cm^3 to be produced), a 50 mA-100 volt electron gun having a special function, and an Ebert–Fastie spectrometer having an effective resolving power of 150,000. (France)

1177 TIME-OF-FLIGHT ATOMIC BEAM MEASUREMENTS WITH A COOLED DISCHARGE SOURCE. Miller, T. M. Entropie; No. 42, 69-73(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

Time-of-flight studies were made on atomic and molecular beams produced by a cooled microwave discharge source. Hydrogen and nitrogen discharges were investigated in detail; results were also obtained for argon and helium. Data are given for ground state beams, metastable components, and low-temperature beams (no discharge). (France)

1178 VELOCITY ANALYZER USING HEXAPOLAR MAGNETS FOR LOW ENERGY HYDROGEN ATOMIC JETS. Duchene, J. L.; Desaintfuscien, Michel; Petit, Pierre; Audoin, Claude (CNRS, Orsay, France). Entropie; No. 42, 76-80(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

A velocity selector for low-energy hydrogen atoms, using the properties of hexapolar magnets is described. Such a magnet behaves like an optical lens for hydrogen atoms. The velocity selectivity is obtained by means of the chromatic aberrations of these lenses. The use of two lenses, whose distance can be varied allows the mean velocity of the transmitted atoms to be controlled. The transmission coefficient of the selector is studied by the phase plane method. The hydrogen atoms are detected by maser amplification. This velocity analyzer is used to study the velocity distribution of an atomic hydrogen beam issued from a source, the teflon walls of which are cooled by liquid nitrogen. (France)

1179 EFFECTS OF DISTURBANCES ON THE INTENSITY OF A SUPERSONIC MOLECULAR BEAM HAVING PLANE SYMMETRY. Hagene, M.; Pasquerault, D. (Univ., Rennes, France). Entropie; No. 42, 80-4(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The experimental intensities obtained with a plane supersonic beam are studied as a function of several parameters: nozzle–skimmer distance; upstream and downstream nozzle pressures. The Mach numbers are compared with those calculated using the Hamel–Willis theory. The fact that, at the minimum intensity, the Mach number is frozen is considered. At larger distances the occurrence of a maximum intensity can be explained by the invasion of the free jet by background molecules and effects linked to the skimmer geometry. A semi-empirical equation that predicts the value and the position of the maximum intensity with its parameters is given. (France)

1180 INTERACTION BETWEEN MOLECULAR BEAMS AND ELECTROLYTICALLY PRODUCED SOLID SURFACES (Al_2O_3) AS FUNCTION OF THE SOLID STRUCTURE PRODUCED ON DIFFERENT REACTION CONDITIONS. Aigner, J.; Jaeger, D.; Nikuradse, A. Entropie; No. 42, 89-91(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

Solid Al_2O_3 surfaces were formed under rigorously defined reaction conditions. The plastic deformability and the microhardness of these reproducible layers were studied together with the intensity distribution of the molecular jets reflected by these layers. This research demonstrates that the intensity distribution of the reflected molecular jets is a function of the physical and technological quality of the aluminum oxide layer. (France)

1181 NEW RESULTS ON THE RELATION BETWEEN THE INTENSITY DISTRIBUTION OF REFLECTED MOLECULAR JETS AND THE SPATIAL DISTRIBUTION OF THE ELEMENTARY CRYSTAL CELLS OF A fcc SOLID. Nikuradse, A.; Weidner, J. Entropie; No. 42, 95-8(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The intensity distribution of molecular beams reflected by solid surfaces depends on the spatial distribution of the elementary cells of the solid. Previous attempts have been made to study this dependence for the case of an idealized disorder in the orientation of the elementary cells. If the cell arrangement is modified, e.g., by an external force, there is no longer an ideal disorder. The spatial distribution was investigated in this case. A Gaussian curve with a displaced maxima was obtained. This displacement leads to a shift in the intensity distribution calculated for the reflected molecular beams. The effect of treating the surfaces has already been experimentally investigated. (France)

1182 PHENOMENA OBSERVED IN THE DEEP INTERACTION OF A HIGH ENERGY MOLECULAR JET WITH A SOLID. Devienne, F. M.; Lenteri, H. (Univ., Nice). Entropie; No. 42, 98-101(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

Various phenomena were observed when a thin Au film without a substrate was bombarded with a high-energy molecular jet. A reduction in the secondary electron emission coefficient occurs when the film thickness is less than 5000 A. A certain fraction of the molecular beam passes through the thin film; this fraction increases as the thickness of the film decreases. In addition, other phenomena, e.g., positive or negative emission, are observed at the back face of the film. (France)

1183 RECENT APPLICATIONS OF MOLECULAR JETS IN CHEMISTRY. Devienne, F. M. (Univ., Nice). Entropie; No. 42, 104-10(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The applications of molecular beams in chemistry have become more widespread during recent years. An application is the chemical effects of such beams when impinging on solid surfaces. Another application is the determination of the inelastic cross sections involving rearrangement of the atom; different methods can be used for this determination, the convergent or superimposed beam method being of particular interest. Fundamental phenomena associated with inelastic collisions can be studied using the crossed-molecular-beam method. A new field of applications is the effects induced by the impact of high-energy molecular beams on a gaseous mixture (production of chemical reactions and observations of intermediate states formed during the reaction). (France)

1184 INTERACTION OF ATOMIC HYDROGEN AND OXYGEN BEAMS WITH A LiF-CRYSTAL SURFACE. Hoinkes, H.; Nahr, H.; Wilsch, H. (Univ., Erlangen, Ger.). Entropie; No. 42, 111-13(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The reflection of thermal atomic beams of hydrogen and oxygen by the (001) plane of a LiF crystal was studied experimentally. Diffractive distributions appeared in the case of atomic hydrogen reflections. These distributions contain first-order diffraction peaks and minima resulting from transitions associated with the states adsorbed by the surface. A pure Morse-type potential is deduced for the gas–surface interaction. In the case of atomic hydrogen, the reflection distributions correspond to a predominantly cosine shaped curve with a subspecular lobe. The distribution of the directly reflected atoms is compared with calculations made using the cube model. (France)

1185 CLUSTER SIZES OF CONDENSED MOLECULAR BEAMS: POTASSIUM SCATTERING RESULTS COMPARED WITH TIME-OF-FLIGHT MASS SPECTROMETRY. Gspann, J. (Univ., Karlsruhe, Ger.). Entropie; No. 42, 129-32(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The mean size of the clusters in condensed molecular nitrogen beams was established from measurements of the attenuation of an atomic jet crossing a potassium beam. The results obtained are in good agreement with the values obtained for the mean size of singly ionized clusters using time-of-flight techniques in an accelerating field. The results lead to the conclusion that the clusters are solid nitrogen spheres capable of being ionized by electron impact without significant cluster material losses occurring. (France)

1186 DETERMINATION OF THE DIFFERENTIAL COLLISION CROSS-SECTIONS FOR NEON–ARGON, METHANE–ARGON, ETHANE–ARGON, AND ARGON–ETHANE COUPLES. Schimpke, B.; Schugerl, K. (Technische Univ., Hanover). Entropie; No. 42, 133-6(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The angular distribution of the particles scattered in collisions between two crossed molecular beams was measured. In the small-angle region, a classical description of the angular distribution can be made using the Van-der-Waals-forces with an s = 6 form parameter for the attractive potential term. At larger angles, the resolving power of the apparatus was not sufficient to allow the oscillations and rainbow extrema expected to be detected. (France)

1187 DETERMINATION OF COLLISION CROSS SECTIONS BETWEEN 3 AND 550 eV. Devienne, F. M.; Bark, P.; Roustan, A. (Univ., Nice). Entropie; No. 42, 140-2(1971). (In French).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

A method for measuring total cross sections for energies less than a few dozen eV was developed. The method was established for argon and oxygen ions having energies up to 3 eV. It was also used for molecular argon beams obtained by charge exchange. A new photographic method was developed. (France)

1188 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTION FOR THE SCATTERING OF METASTABLE ARGON ON RARE GASES. Nenner, T. (CEN de Saclay, Gif-sur-Yvette, France). Entropie; No. 42, 142-6(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The velocity dependence of the total scattering cross sections of Ne, Ar, Kr, and Xe for a metastable argon beam was measured. Hydrogen was used to aerodynamically accelerate a supersonic argon beam. It was possible to vary the mean velocity of the argon atoms between 560 and 2200m/s by altering the composition of the mixture. The accelerated argon atoms were excited by slow electrons and the drop in intensity of the metastable atomic beam after traversing a scattering chamber was measured. The effective total cross sections were calculated using the JWKB approximation and the Lennard–Jones 12–6 potential. The potential parameters were estimated by fitting the calculated functions to the experimental data. (France)

1189 MULTIPARAMETER POTENTIAL FOR Ar + Ar FROM HIGH RESOLUTION DIFFERENTIAL CROSS SECTION MEASUREMENTS. Parson, J. M.; Lee, Y. T. (Univ. of Chicago). Entropie; No. 42, 146-8(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The low-energy differential cross section for Ar + Ar was measured by crossing two supersonic molecular beams with a mass spectrometric detector. The rainbow structure, the oscillations caused by nuclear symmetry, and the general curve shape allowed the determination of a new multiparameter potential. The vibrational levels of this potential are in agreement with experiment. (France)

1190 VELOCITY DEPENDENCE OF THE TOTAL CROSS-SECTION OF SOME NOBLE GASES. Bredewout, J. W.; Bosman, N. J.; Visser, A. G.; Korving, J.; van den Meijdenberg, C. J. N. (Leiden State Univ.). Entropie; No. 42, 148-51(1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The velocity dependence of the total cross section for an argon beam scattered by krypton was measured in the 550 to 4300m/s velocity range. The product of the potential parameters ϵ and $r_{(m)}$ was accurately determined from the location of five well-resolved glory extrema. (France)

1191 ROTATIONAL TRANSITIONS BY NITROGEN RARE-GAS COLLISIONS. Scott, P. B.; Mincer, T. R. (Univ. of Southern California, Los Angeles). Entropie; No. 42, 153-8 (1971).

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

The rotational excitation of a molecular beam of nitrogen by impact with a second beam of argon was observed. The spectrographic method used for this experiment and the experimental arrangements are discussed briefly. It is proposed to make a numerical simulation of the experiment by using tentative molecular parameters. A semi-classical calculation gives the probability of transition. The mean values of the angle parameters, the impact distance, and the speed and state can be used to compare the measured distribution of states with the calculated function (France)

1192 ELECTRONIC EXCITATION IN CROSSED BEAMS OF ALKALI IONS AND SODIUM ATOMS. **Aquilanti, V.; Liuti, G.; Vecchio-Cattivi, F.; Volpi, G. G. (Univ., Perugia, Italy). Entropie; No. 42, 158-62(1971).**

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

Inelastic collisions between Li^+, Na^+, and K^+ and Na leading to electronically excited atoms were studied using crossed molecular beams and optical techniques. Absolute cross sections were determined using a combined resonance/fluorescence measurement technique; the energy dependence of the cross sections was investigated in an energy range lying between a few eV and 1.5 keV. (France)

1193 ELASTIC DIFFERENTIAL SCATTERING OF METASTABLE MERCURY 6^3P_2 FROM K AND Hg. **Darwall, E. C.; Fleundy, M. A. D.; Lawley, K. P. (Univ. of Edinburgh). Entropie; No. 42, 162-5(1971).**

From third international symposium on molecular beams; Cannes, France (29 Jun 1971). See CONF-710629.

Preliminary results on the differential elastic projection of electronically excited Hg, K, and Hg are given. An intersecting-beam technique was used in which the metastable flux is produced by electron bombardment. In the KHg* system, at least two potentials are required to interpret the observations. Primary and secondary halos are observed with a K/Hg potential. These results indicate $\epsilon = 2.8 \times 10^{-14}$ ergs and $\sigma = 4.9$ A. A different potential, KHg, having 12:6 L.J. parameters leads to the following tentative values: $\epsilon = 1 \times 10^{-14}$ ergs and $\sigma = 6$ A. In the Hg*Hg system, the halo does not appear, but the supernumerary structure indicates the existence of a deep trough with $\epsilon = 5 \times 10^{-14}$ ergs (approximately). (France)

1194 SECONDARY ION EMISSION DURING BOMBARDMENT OF A BORON SURFACE WITH ALKALI-METAL IONS. **Arifov, U. A.; Khadzhimukhamedov, Kh. Kh.; Yunusov, A. I.; Kiskachi, A. Yu.; Lyutovich, A. S. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 4, 18-20(1972). (In Russian).**

The emission of secondary ions as a result of the bombardment of a boron target by alkali-metal ions with 50 to 1,200 eV energy was studied. Three coefficients were determined as functions of the bombarding energy at 1,500°K of K^+ ions: the scattering, ion diffusion, and total secondary ion emission coefficients. Scattering coefficients were determined at 300°K for the ions Li^+, K^+, Rb^+, Na^+ and Cs^+ from 0 to 1.2 keV. (K.S.W.)

1195 STABILITY OF HIGH-INTENSITY ELECTRON BEAM. II. **Ikuta, Kazunari (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 33: No. 5, 1436-41(Nov 1972).**

A necessary stability condition for the electrostatic perturbation is obtained for a high intensity highly relativistic electron beam with circular cross section. Both the relativistic effect and the strong external magnetic field may stabilize the electrostatic instability. (auth)

1196 INTERACTION OF HYDROGEN AND DEUTERIUM BEAMS WITH METAL SURFACES. **Chappell, R.; Hayward, D. O. (Imperial Coll. of Science and Tech., London). pp 189-201 of Adsorption-Desorption Phenomena. /Ricca, F. (ed.). London; Academic Press (1972).**

From second international conference on adsorption-desorption phenomena; Florence, Italy (14 Apr 1971). See CONF-710459.

Earlier work in this field is first reviewed, and it is stated that much of this was performed under poor vacuum conditions and with inadequate facilities for outgassing of the metal, with the result that many of the surfaces were contaminated. With the exception of D on Ag, all the scattering data reported showed a very sharp specular peak superimposed on a broader lobe, and this appears to be typical of scattering from clean surfaces. In the experimental work described in this paper, the systems chosen for study involved the reflection of H and D beams at the surfaces of polycrystalline Pt and polycrystalline and single-crystal Mo. All the work was performed under ultrahigh vacuum condition, so that contamination of the surfaces by adsorption from background gases was not a problem. Observations made included changes in the spacial distributions of scattered gas as molecules from the beam became adsorbed on the surfaces. Details are given of the apparatus used, target preparation, experimental procedure, and scattering results. (15 references) (UK)

Atomic and Molecular Properties

Refer also to abstracts 1223, 1641, and 1913.

1197 (KFKI-72-42) PERTURBATION OF ATOMIC LEVELS NEAR TO THE IONIZATION THRESHOLD IN HIGH INTENSITY LASER FIELD. **Bakos, J.; Kiss, A.; Szabo, L.; Tendler, M. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Jul 1972. 8p. (CONF-720558-1). Dep. NTIS (U. S. Sales Only).**

From seventh international conference on quantum electronics; Montreal, Canada (8 May 1972).

The general multiphoton probability versus light intensity dependence of the triplet metastable He atom was measured in the case of four-photon resonances very near to the ionization threshold (about 600 cm^{-1}). A big value of the Stark shift was observed. (auth)

1198 (LA-DC-72-1149) THEORY OF RARE EARTH ENERGY LEVELS AND SPECTRA. **Cowan, Robert D. (Los Alamos Scientific Lab., N. Mex.). 1972. 38p. (CONF-721033-1). Dep. NTIS.**

From third international conference on beam foil spectroscopy; Tucson, AZ. (2 Oct 1972).

The characteristic properties of rare earth atoms and ions are consequences of the existence of a tightly-bound 4f orbital, beginning at atomic number 57. The ground and low-excited configurations of these atoms are comprised of unfilled 4f, 5d, 6s, and 6p shells and for the most part are exceedingly complex. Certain simplifications in the level structure and spectra do exist when no 5d electrons are present, because the 4f-6s and 4f-6p interactions are comparatively weak. However, new complications arise at high ionization stages because 5p electrons may be removed before all 4f electrons have been exhausted. (auth)

1199 (NBS-SPEC. PUBL-366) BIBLIOGRAPHY ON ATOMIC LINE SHAPES AND SHIFTS (1889 THROUGH MARCH 1972). **Fuhr, J. R.; Wiese, W. L.; Roszman, L. J. (National Bureau of Standards, Washington, D. C.). Sep 1972. 165p. GPO $1.75.**

This general annotated bibliography on atomic line shapes and shifts covers exhaustively the atomic spectral line broadening literature in about 1400 separate references extending from 1889 through March 1972. The bibliography contains four major parts: (1) All general interest papers are cataloged according to the broadening mechanisms (and, further, according to special topics under several of the mechanisms) and as to whether the work is a general theory, a general review, a table of profiles or parameters, a comment on existing work, a study of general experimental measurement techniques, or an experimental effort of general importance. Also included are selected papers on important applications of line broadening and on miscellaneous topics relating to atomic spectral line shapes and shifts. (2) In Part 2, all papers containing numerical data are ordered as to element, ionization stage, and broadening mechanism (in the case of foreign gas broadening the perturbing species are listed), and it is indicated whether the data are experimentally or theoretically derived. (3) While in the two preceding parts of the bibliography the references are listed for brevity by identification numbers only, in Part 3 all references are listed completely by journal, authors, and title and are arranged chronologically and alphabetically within each year according to the principal author. (4) A final section contains a list of all authors and their papers. (auth)

1200 ANALYSIS OF REDUCED DENSITY MATRICES IN THE CO-ORDINATE REPRESENTATION. III. ELECTRON DENSITY AND CORRELATION IN THE GROUND STATES OF H_2 AND THE H_6 RING SYSTEM WITHIN SOME APPROXIMATIONS OF THE SIMPLE LCAO TYPE. **Sperber, Gunnar (Univ. of Uppsala). Int. J. Quant. Chem.; 6: No. 5, 881-98(Sep 1972).**

The electron density and spatial correlation as given by the MO, VB and AMO methods for H_2 and H_6 are studied by means of diagrams. For comparison, diagrams representing accurate wave functions for H_2 are also given. The study of model functions representing localized bonds leads to results concerning the nature of localized electron pairs in agreement with those of Lennard-Jones. (auth)

1201 LIFETIME MEASUREMENTS OF EXCITED ELECTRONIC STATES IN ATOMIC HELIUM AND THE MOLECULAR HYDROGEN CONTINUUM. **Thompson, Richard T. Jr. Norman,**

Okla.; Univ. of Oklahoma (1972). 133p. University Microfilms Order No. 72-23,118.

Thesis.

The most probable results of 199 individual lifetime measurements of excited states of helium at different pressures are presented. The measurements include samples from single and triplet S, P, and D angular momentum states and principle quantum number state through n = 11. The data obtained indicate a more universal resonance transfer phenomenon than previously envisioned. The data show evidence of fast decay components on the order of n^1P for all angular momentum states above n = 5. A detailed description of the digital computer programs coded for a least-square analysis of the raw data is presented as well as a detailed description of equipment modifications and developments. The data were obtained by coincidence counting using a pulsed discharge applied to an inductively heated inverted cylindrical diode configuration. Some new lifetime measurements for the hydrogen molecular continuum are used in conjunction with some previous measurements to support a model of two states coupled in close resonance. (Diss. Abstr. Int., B)

1202 NEUMANN SERIES SOLUTION FOR THE ATOM–RIGID ROTOR COLLISION. O'Brien, T. J.; Holloway, T. T. (Texas Tech. Univ., Lubbock). J. Math. Phys.; 13: No. 10, 1485-8(Oct 1972).

The solutions of the coupled differential equations arising in the quantum mechanical discussion of the collision of an atom with a rigid, rotating diatom are written as Neumann series, i.e., expanded in terms of spherical Bessel functions. The coefficients of these series are generated by a set of coupled recursion relations. The formalism is limited to potentials less singular than r^{-2} at the origin. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 1294 and 1525.

1203 ANOMALOUS ANNIHILATION OF POSITRONS IN SEVERAL SOLID HYDROCARBONS. DeBlonde, G. (Univ. of Manitoba, Winnipeg); Chuang, S. Y.; Hogg, B. G.; Kerr, D. P.; Miller, D. M. Can. J. Phys.; 50: No. 14, 1619-22(15 Jul 1972).

In previous experiments with positrons annihilating in liquid organic materials (Hogg et al.), the measurements of I_N (intensity of the low-momentum component from angular correlation data) and I_2 (intensity of the long-lived component from lifetime measurements) have resulted in $I_N = I_2/3$ within experimental error. For samples of CH_4, C_6H_6, and C_6H_{12}, measurements in the liquid state yield the expected equality between I_N and $I_2/3$. However, in the solid state for these substances, there is a marked disagreement between I_N and $I_2/3$. The value of I_N in all cases is essentially zero, suggesting that no positronium is formed, but the value of I_2 remains large. (auth) (Canada)

Collision Phenomena

Refer also to abstracts 818 and 1580.

1204 THEORETICAL STUDIES ON NONRESONANT CHARGE-TRANSFER PROCESSES USING A MULTISTATE MOLECULAR WAVE-FUNCTION APPROACH: $Li + Na^+ \rightleftharpoons Le^+ + Na$. Melius, Carl F.; Goddard III, William A. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 29: No. 15, 975-8(9 Oct 1972).

The charge-transfer processes for the collisions $Li + Na^+ \rightarrow Li^+ + Na$ and $Na + Li^+ \rightarrow Na^+ + Li$ were studied theoretically using the first six molecular states in a multistate impact-parameter approach (using the Born–Oppenheimer breakdown terms to couple the states). The results lead to a rather simple description of the charge-transfer process involving primarily transitions between the $1^2\Sigma^+$ and $2^2\Sigma^+$ states and between the $2^2\Sigma^+$ and $1^2\Pi$ states of the $LiNa^+$ quasi molecule. (auth)

1205 ORBITING RESONANCES IN THE SCATTERING OF H ATOMS BY MERCURY AT THERMAL ENERGIES. Schutte, A. (Univ., Geneva); Bassi, D.; Tommasini, F.; Scoles, G. Phys. Rev. Lett.; 29: No. 15, 979-82(9 Oct 1972).

The energy dependence of the integral elastic-collision cross section for scattering of hydrogen and deuterium atoms by mercury at thermal energies was measured. For hydrogen at ca 1.4×10^5 cm^{-1} evidence was found for a structure superimposed on the glory pattern. This can be attributed to two overlapping orbiting resonances and represents the first observation of quasi-bound vibrational–rotational levels of a diatomic molecule through scattering measurements. (auth)

1206 INELASTIC ENERGY LOSSES AND IONIZATION IN EXCITATION OF OUTER AND INNER ELECTRON SHELLS DURING ATOMIC COLLISIONS. Afrosimov, V. V.; Gordeev, Yu. S.; Polyanskii, A. M.; Shergin, A. P. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 63: No. 3, 799-812(Sep 1972). (In Russian).

The inelastic energy-loss spectra and ionization involved in strong collisions between He^+, N^+, Ne^+, and Cl^+ ions and Ne and Ar atoms are studied in the keV initial-energy range. The kinetic energies, charge states, and scattering angles of the two atomic particles, partners of a single collision act, are measured simultaneously. Discrete lines ascribed to vacancy formation in the inner shell of one of the particles in the inelastic energy-loss spectra are observed for all colliding particle pairs, excluding He^+–Ar, on intersection of the inner shells. Experiments indicate that vacancies are produced in shells with lower electron binding energy. From an analysis of the scattered-particle charge distributions it may be concluded that autoionization states, related to excitation of outer shells, decay during the collision when the particles are still interacting. An estimate shows that with approximately equal probability the inner vacancies are filled up during and after the collision. A comparison of the results of experiments on inelastic energy-loss spectra and Auger electron spectra and x-ray spectra yields identical values for the threshold internuclear distances at which the inner shells are excited and identical cross sections for vacancy formation and Auger-electron formation. For interpretation of the experimental results a model is employed in which electron transitions in a quasi molecule formed at the moment of collision are considered. It is shown that the model can explain the inelastic energy losses observed and the probabilities for vacancy formation. It is shown that simultaneous interaction between a large number of quasi molecule electron levels should be taken into account in analyzing vacancy formation in the N–Ar or Ne–Ar systems. (auth)

1207 CONTRIBUTION OF COLLISIONS TO MULTIPHOTON RESONANCES IN GASES. Perel'man, N. F.; Kovarskii, V. A. (Inst. of Applied Physics, Kishinev, USSR). Zh. Eksp. Teor. Fiz.; 63: No. 3, 831-7(Sep 1972). (In Russian).

The collision between a slow electron or neutral atom and atoms of a gas in the field of a strong electromagnetic wave is considered. The cross section for the impact–multiphoton excitation mechanism for a hydrogen atom colliding with an electron is calculated. The energy distribution of scattered electrons as a function of electromagnetic-radiation frequency and intensity is obtained. The collision cross section and mean excitation probability per unit time are calculated for the case of collisions between neutral atoms in a Maxwellian gas. It is shown that on growth of gas pressure the impact–multiphoton ionization mechanism predominates over the direct multiphoton ionization mechanism. (auth)

1208 MEASUREMENT OF THE CROSS SECTION FOR K-SHELL IONIZATION BY ELECTRON IMPACT. Huebner, Helmut; Ilgen, Karl; Hoffmann, K.-W. (Univ., Stuttgart). Z. Phys.; 255: No. 3, 269-80(1972). (In German).

Absolute cross sections for K-shell ionization in thin foils of Ag and Cu by electron impact were determined from NaI(Tl) scintillation spectrometer measurements of K x rays and with the aid of a β-ray spectrometer. The energies of the bombarding electrons were 114 keV for Ag and 81, 114, and 152 keV for Cu. The results for Cu are in excellent agreement with the relativistic calculations of Arthurs and Moiseiwitsch. A brief discussion of the values obtained in comparison with earlier experimental and theoretical results is given. (auth)

1209 LOW-ENERGY SCATTERING BY A COMPOUND SYSTEM: POSITRONS ON HYDROGEN. Rosenberg, Leonard. New York, N. Y.; New York Univ. (1959). 49p. University Microfilms Order No. 72-24,533.

Thesis.

The formalism, developed by Kato, that gives upper and lower bounds on the phase shift for the scattering of a particle from a center of force is shown to have useful applications when the scatterer is a compound system. In particular, the problem of low-energy positron scattering by atomic hydrogen, with zero total orbital angular momentum, is studied. It is shown that at zero energy the ordinary variational calculation, which ignores second-order contributions, provides a bound on the scattering length, from which a bound on the cross section is deduced. For nonzero energies a bound on the phase shift may similarly be obtained, but for a fictitious problem with cutoff potentials. If the energy is sufficiently small (less than 3 eV) the error thus incurred is expected to be negligibly small. Numerical calculations performed at k = 0 and $ka_0 = 0.2$ lead to the result that the effects of polarization are large enough to cause the positron to be on the whole attracted to the hydrogen atom. It is shown, independently of the Kato formalism, that in general a bound on the scattering

length may be obtained from the ordinary variational calculation provided no composite bound state exists for the system. (Diss. Abstr. Int., B)

1210 LOW-ENERGY PROTON–ARGON DIFFERENTIAL SCATTERING CROSS SECTION MEASUREMENTS AND CALCULATIONS. Todd, Leo W. Jr. Potsdam, N. Y.; Clarkson Coll. of Tech. (1972). 112p. University Microfilms Order No. 72-25,725.

Thesis.

Differential cross sections were measured for collisions in which 225-, 250-, and 300-eV protons scatter, without electron capture, from argon atoms at angles between 3 and 25 milliradians. The angular resolution of the detector was approximately 2 milliradians. Using an analytic form for the interaction potential, the corresponding quantum elastic differential cross sections were calculated and compared with experiment. The slope of the experimental cross section agrees reasonably with the slope of the calculated elastic cross section at 225 eV; it does not agree as well at 250 eV and is in total disagreement at 300 eV. Thus, it appears that the energy of 225 eV is an approximate upper bound above which the differential proton–argon cross section may no longer be described solely as an elastic process. Cross sections for the proton–atomic–hydrogen collision, which resulted from an earlier investigation, are included. (Diss. Abstr. Int., B)

1211 PERTURBATION CALCULATION OF THE INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. Klein, Milton M. New York; New York Univ. (1956). 60p. University Microfilms Order No. 72-24,503.

Thesis.

A perturbation calculation was made of the inelastic scattering of fast electrons by hydrogen atoms for the 2S and 2P cases, using for the perturbation only the interaction between the incident electron and the bound electron. The results are then compared to leading-order terms in the energy with calculations by the more customary perturbation scheme. The results show a difference in energy dependence between the two perturbation schemes for both direct and exchange scattering. The present method shows that, in addition, exchange scattering is negligible compared to direct scattering, whereas the conventional perturbation scheme indicates that direct and exchange scattering are of the same order of magnitude. Calculations by the present method are considerably more difficult than those by the conventional method. The results show, however, that exchange scattering may be neglected in the calculations. In addition, the calculations for direct scattering may be simplified considerably with good results, by replacing one of the wave functions in the scattering integral by a wave function that neglects the effect of the nucleus (method of altered states). The calculations by the present method should not, therefore, be much more laborious than those by the conventional method. The present method is probably more accurate than the conventional perturbation scheme, but experimental work will be necessary to determine which method is more valid. (Diss. Abstr. Int., B)

1212 VARIATIONAL CALCULATION OF THE SCATTERING CROSS SECTION FOR NEARLY ZERO-ENERGY ELECTRONS BY HYDROGEN ATOMS. Greenberg, Howard. New York; New York Univ. (1957). 55p. University Microfilms Order No. 72-24,491.

Thesis.

The cross section for the scattering of electrons by hydrogen atoms at zero energy was calculated using a variational principle of the Hulthen–Kohn type. For single scattering a three-parameter trial function which reduces to an H^- wave function at small electron separations and which has the correct asymptotic form was used. To calculate triplet scattering an antisymmetrized version of the same trial function was used. The effective range for singlet scattering was determined from the scattering length already calculated and the known value of the electron attachment energy for H^-. For triplet scattering an energy-dependent trial function was used to determine the effective range. Using the calculated values of the above parameters the cross section as a function of energy for the range 0 to 0.02 volts was found. The values of the cross section were then used to calculate the resistivity of silicon alloys due to neutral impurity scattering. (Diss. Abstr. Int., B)

1213 TEMPERATURE DEPENDENCE OF He 3^1P EXCITATION TRANSFER CROSS SECTION. Hunter, William Winslow Jr. Blacksburg, Va.; Virginia Polytechnic Inst. and State Univ. (1972). 93p. University Microfilms Order No. 72-23,837.

Thesis.

Inelastic collisions between helium atoms in the 3^1P and 1^1S states can result in radiationless transfers of excitation. Measurements were made to determine the cross section of the excitation transfer and its variation with the mean relative velocity of interacting atoms. The collision process was investigated in low-density (10^{15} to 10^{16} atoms/cm^3) helium gas at four different temperatures between 296°K and 22°K. A 30-keV electron beam provided primary excitation of the 3^1P state. The cross sections were found to be $1.6(\pm 0.3) \times 10^{-15}$ cm^2 at 296°K, $1.3(\pm 0.8) \times 10^{-15}$ cm^2 at 214°K, $1.1(\pm 0.2) \times 10^{-15}$ cm^2 at 82°K, and $1.7(\pm 0.3) \times 10^{-15}$ cm^2 at 22°K. A comparison of the experimental results with the predictions of the Stueckelberg theory for imperfect resonance excitation transfer was made. Results of the comparison indicate that the dipole–dipole interaction is weak compared with possible dipole–quadrupole and quadrupole–quadrupole interactions. (Diss. Abstr. Int., B)

1214 PRODUCTION OF INTENSE SATELLITE LINES IN AUGER SPECTRA OF NITROGEN BY SLOW-PROTON IMPACT. Stolterfoht, N. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett.; 41A: No. 5, 400-2(23 Oct 1972).

Strong satellite lines due to double ionization were observed in nitrogen Auger spectra produced by 50- to 500-keV proton impact. Inner-shell ionization followed by outer-shell ionization or electron capture are expected to take place during the collision process. (auth)

1215 LOW ENERGY ELECTRON SCATTERING TREATABLE AS POTENTIAL SCATTERING? Schwarz, W. H. E. (Univ., Bonn). Z. Phys.; 254: No. 5, 408-17(1972). (In German).

The question in the title essentially reduces to the problem of substituting a local potential for the exchange operator. The most simple target systems are the rare gas atoms; calculations of the 0- to 12-eV elastic electron scattering by these central symmetric closed-shell systems using many different exchange potentials did not lead to satisfactory overall agreement with experimental data. Apparently the exchange operator cannot be simulated by a local energy-independent potential in the positive low-energy region. (auth)

1216 ASSOCIATIVE IONIZATION IN SLOW COLLISIONS BETWEEN ATOMS. II. Koike, Fumihiro (Tokyo Univ.); Nakamura, Hiroki. J. Phys. Soc. Jap.; 33: No. 5, 1426-35(Nov 1972).

Associative ionization in slow collisions of the type $A^* + B \rightarrow AB^+ + e$ is investigated theoretically for the case in which the excitation energy of A^* is smaller than the ionization potential of B. Two cases are considered. First, on the basis of the adiabatic or diabatic representation, a general treatment is described for the case involving a potential-curve crossing. In the second case of no potential-curve crossing a cross section formula that does not require numerical differentiation and thus is of practical usefulness is presented. A rough estimate of the energy dependence of the cross section is also discussed in this case. Some qualitative applications to a hydrogen system are made. (auth)

1217 K-SHELL IONIZATION OF BERYLLIUM BY PROTON AND HEAVY IONS. Terasawa, Michitaka (Tokyo Shibaura Electric Co., Ltd., Kawasaki); Tamura, Tetsuji; Kamada, Hitoshi. J. Phys. Soc. Jap.; 33: No. 5, 1420-5(Nov 1972).

Experimental cross sections are presented for the ionization of K shells of Be in collisions with heavy ions and protons. Bombarding energies for C^+, N^+, O^+, Ne^+, and Ar^+ range from 0.3 to 30 keV/amu, and that for protons is 10 to 200 keV/amu. Proton data show good agreement with the prediction for Coulomb excitation of K-shell electrons. The data for heavy ions are several orders of magnitude larger than for protons. These results are understood in terms of pseudomolecule formation and crossings of molecular orbitals during the collisions. Heavy-ion cross sections tend to converge to the theoretical Coulomb excitation cross sections at energies above about 10 keV/amu. (auth)

1218 RESONANT EXCITATION OF H_2 MOLECULES BY ELECTRON IMPACT. Black, Kenneth F. Houston, Tex.; Rice Univ. (1972). 166p. University Microfilms Order No. 72-26,394.

Thesis.

Close-coupling calculations of the electronic, vibrational, and rotational excitation of H_2 by electron impact were carried out for energies 10 to 13 eV. The calculations exhibit closed-channel resonances in the inelastic cross sections $\sigma(X,v = 0 \rightarrow B,v = 0,1)$. The position of each resonance is determined primarily by the bound-state energy of the closed channel corresponding to the molecule in some vibrational state of the C electronic state (and some rotational state) and the extra electron in a p-wave angular momentum state. Other closed channels with different partial waves and/or different rotational states of H_2 provide second-order perturbations to the resonance energy, which may result in shifts in position by more than 1 eV. It is

found that no resonance occurs unless the effects of exchange are included, which is done via an effective exchange potential with an adjustable scaling factor that is varied slightly from the Gaspar–Kohn–Sham value to give a resonance position in agreement with experiment. The width of the resonance is given by the sum of the partial widths for decay of the resonance into the various exit channels. The resonances in the integrated inelastic cross sections have half-widths of about 10 MeV with only the exit channels X,v = 0 and B,v = 0,1 present. The results, although inconclusive, suggest that each experimentally observed resonance is composed of several unresolved resonances corresponding to different rotational states (states of total angular momentum) of the H_2^- system. (TSS) (Diss. Abstr. Int., B)

1219 LOW-ENERGY STUDIES OF THE EXPERIMENTAL ELASTIC DIFFERENTIAL CROSS SECTIONS FOR THE SYSTEMS $H^+ + He$, $H^+ + Ne$, AND $He^+ + He$. Rich, William Guy. Williamsburg, Va.; Coll. of William and Mary (1972). 143p. University Microfilms Order No. 72-24,436.

Thesis.

The experimental elastic differential cross sections for low center-of-mass collision energies for ion–atom scattering are reported for heteronuclear systems ($H^+ + He$, E = 4 eV; $H^+ + Ne$, E = 5.71 eV) and for the homonuclear systems ($^3He^+ + {}^3He$, $^4He^+ + {}^4He$, $^3He^+ + {}^4He$, $^4He^+ + {}^3He$, E = 6 eV). The experiments are performed at energies low enough to prevent inelastic scattering, but high enough to avoid classical orbiting. The intermolecular potentials retrieved from these experiments are reported and are compared with the results of existing ab initio calculations. Two approaches are utilized in the analysis of the experimental data: (1) A parameterized analytic (Morse) potential is used in the calculation of the JWKB phase shifts, which are then used in the Rayleigh–Faxen–Holtzmark partial-wave sum to determine the scattering amplitude and thereby the differential cross section. By an iterative variation of the potential parameters, the calculation is brought into agreement with the experiment. (2) Using the convenient S-matrix (diagonal) parameterization of the scattering amplitude in the complex l-plane, which has been developed by E. A. Remler, the differential cross section is calculated and is iteratively compared to the experiment by varying the S-matrix parameters. A result of this calculation is an analytic expression for the phase shifts, which can be used in a formal inversion calculation of the intermolecular potential. One-state intermolecular potentials are sufficient to calculate the differential cross section for the heteronuclear systems, but two-state intermolecular potentials (gerade and ungerade) are necessary for the homonuclear calculations. The gerade potential is held constant (i.e., is assumed to be known from ab initio calculations) and only the ungerade potential is varied in the analysis of the homonuclear systems. The experimental method used in this work to obtain high-resolution data from which the intermolecular potentials are retrieved is the best method presently available for the determination of such potentials. (Diss. Abstr. Int., B)

1220 SCATTERING OF POSITRONS BY HYDROGEN ATOMS. Chan, Yu Fai. London, Ont.; Univ. of Western Ontario (1972). National Library of Canada, Ottawa.

Thesis.

The S-wave scattering of positrons by hydrogen atoms in the energy region up to the first excitation threshold of hydrogen is studied. In the upper part of this energy region, the two reactions $e^+ + H(1s) \rightarrow e^+ + H(1s)$ and $e^+ + H(1s) \rightarrow Ps(1s) + H^+$ are possible, giving the open channels. The closed-channel part of the wave function is approximated by a sum of short-range correlation terms. Equations for the scattering functions and the coefficients of the expansion in the correlation terms are obtained variationally. The formulation satisfies the bound principle: the phase shift and the eigenphases are lower-bound estimates to the exact values. For energies in the elastic scattering region, the phase shifts are in very good agreement with those from the accurate calculation of Bhatia et al. (Phys. Rev., A3: 1328 (1971). In the inelastic region, this thesis presents new results, which by the bound principle are better than previous results. A detailed hunt for resonances in the energy below the n = 2 excitation threshold of hydrogen produced negative results. As a test of the flexibility and capability of the trial wave function to produce a resonance, the same wave function without the positronium channel term is used to study the electron-hydrogen problem without exchange. A resonance is reproduced with position very close to that obtained by Burke and Schey (Phys. Rev., 126: 1147 (1962)) using a three-state approximation. In addition, at low energy, large variations in phase shift are observed. An independent calculation, using a five-state close coupling approximation, produces similar results. The coupled integrodifferential equations for the scattering functions are first converted to coupled integral equations, and the values of the functions at a specified net of points are obtained by solving a system of approximating linear algebraic equations. Numerical integrations are carried out using the Gauss–Legendre quadrature, if the limits are finite, or the Gauss–Laguerre formula, when the upper limit is infinite. These decrease the dimension of the system of linear equations to 75 × 75, a manageable and economical size. Most of the numerical calculations were performed on a CDC-6600 computer. (Diss. Abstr. Int., B)

1221 APPROXIMATE THEORIES OF CHARGED-PARTICLE COLLISIONS WITH ATOMS. Thomas, Brian Kay. Pittsburgh; Univ. of Pittsburgh (1972). 134p. University Microfilms Order No. 72-22,962.

Thesis.

In the first part of this thesis the classical binary encounter model for ionization by charged-particle impact is modified to permit evaluation of the cross section for ionization of positive ions by electron impact. The modified model is partly geometrical in motivation and development. General scalable expressions for the cross sections are obtained, and the results are compared with available experimental data and quantum theoretical approximations. The dependence on ionic charge is discussed, and a simple physical interpretation emerges. The results indicate that this model is as reliable as the Born approximation for this process. In the second part the Glauber approximation is applied to charged-particle–hydrogen-atom collisions. Emphasis is placed upon obtaining closed-form expressions for the Glauber amplitudes and the resulting cross sections. In particular, the Glauber scattering amplitudes for the excitation of the ns and np levels of atomic hydrogen by arbitrary, structureless charged particles incident upon the ground state were obtained in closed form. These new expressions require no numerical integration. For small n, the amplitudes reduce to simple sums of hypergeometric functions. A selection rule for arbitrary transitions in atomic hydrogen is derived, and general expressions for the nonzero Glauber scattering amplitudes are given. The integrated (over scattering angle) cross section for elastic scattering by ground-state atomic hydrogen is then obtained in closed form. The Glauber approximation then is applied specifically to elastic scattering of protons by hydrogen atoms and to excitation of the 2s, 2p, 3s, and 3p levels of the hydrogen atom by proton impact. The predicted differential and integrated elastic and excitation cross sections are compared with other calculations and with the available experimental data. The Glauber approximation is a considerable improvement over the Born approximation at energies $<\sim 200$ keV and the distortion approximation at energies $<\sim 100$ keV. At energies $>\sim 200$ keV, the calculated total excitation cross sections are close to the Born approximation. Nevertheless, over most of the angular range the calculated differential cross sections are very different from the Born approximation. Above 10 keV the results are in good agreement with the only available experimental data (1s–2p), indicating that above ~10 keV the Glauber approximation should yield reasonable estimates for proton–hydrogen-atom collision cross sections. (TSS) (Diss. Abstr. Int., B)

Atomic Theory

Refer also to abstracts 1198 and 1200.

1222 THEORY OF RADIATION EMISSION BY A SYSTEM OF WEAKLY INTERACTING PARTICLES. Gadomskii, O. N.; Nagibarov, V. R.; Solovarov, N. K. (Kazan Physical-Technical Inst., USSR). Zh. Eksp. Teor. Fiz.; 63: No. 3, 813-19(Sep 1972). (In Russian).

The hamiltonian for interaction between an external electromagnetic field and an atomic system is obtained by taking into account the retarded part of the Coulomb interaction between them. The intensity of emission (absorption) of electromagnetic radiation is calculated with the aid of the hamiltonian. Allowance for the retarded part of the Coulomb interaction between atoms results in the appearance of new (as well as the usual) terms in the formulas for the intensity. Numerical estimates show that allowance for the new terms is particularly important in the infrared frequency range, providing the exciting field is coherent. As an example, the intensity of superemissive signals contains, beside the usual term $\sim N^2$, also a number of terms of higher powers of N (N is the number of atoms). The hamiltonian is employed for calculating the intensity of superemissive signals of the light-induction or echo type. An analysis of the expressions obtained shows that, along with emission at the fundamental frequency ω_{12}, a system of atoms under certain conditions may emit (absorb) detectable power at the double frequency $2\omega_{12}$ (ω_{12} is the splitting frequency in the spectrum of an isolated atom). For N = 2 this corresponds to a

simultaneous radiative transition of both atoms to the ground (excited) state. (auth)

1223 INTEGRAL EQUATION TREATMENT OF BOUND STATE ATOMIC SYSTEMS AND COLLINEAR He–H_2^+ PROTON TRANSFER REACTIVE COLLISIONS. Cooper, Willis Grant. Houston, Tex.; Univ. of Houston (1971). 192p. University Microfilms Order No. 72-22,980.

Thesis.

A unique prescription is given for obtaining the Green function for N free particles, which can have different masses. The approach is systematic and straightforward. A coordinate transformation of the Fourier integral representation of the N-particle noninteracting Green function facilitates the integration over $3N-1$ angular variables of wave number space, using the orthogonal properties of Jacobi polynomials. A single radial integral can then be evaluated. The resulting Green function representation may be of use in applying the integral form of Schrödinger's equation to calculate the ground and excited states of atoms. The Sams–Kouri method for noniteratively solving integral equations is used to solve the integral form of Schrödinger's equation for He such that the Hartree–Fock approximation is avoided and the inclusion of nuclear motion is straightforward. An exact formalism is presented, which requires the solution to coupled integral equations, and the method for generalizing to many-electron atoms is indicated. Calculations are reported for a single integral equation approximation to He, which illustrates the essential features of the method. The energy value obtained is approximately 85% of the total binding energy. Calculations for the H atom are given so comparisons with an exactly soluble atomic problem can be made, and the energy values for the ground and first three excited states are in excellent agreement with the exact values. Excited state calculations are found to be no more difficult than those for the ground state. Reactive collision probabilities are calculated in the collinear approximation for the proton transfer scattering system of $He + H_2^+ \rightarrow HeH^+ + H$, where the cross derivative term in the kinetic-energy operator is neglected. The total energy range of 0 to 3 eV includes the first four vibrational states of H_2^+ and the first three energy states of HeH^+. The coupled channel τ operator equations of Baer and Kouri are employed to execute the calculations and the flux conservation is consistently within the range of 0.92 to 0.99. The graphs of total reaction probability versus relative translational energy compare favorably with the experimental cross-section-versus-energy curves of Chaupka, Berkowitz, and Russell. Fermi's Golden Rule is one of two descriptive models used to interpret and discuss the data. (Diss. Abstr. Int., B)

1224 QUANTUM AND CORRELATION CORRECTIONS TO THE THOMAS–FERMI ATOMIC MODEL. PART I. GREEN'S FUNCTION METHOD FOR QUANTUM CORRECTIONS TO THOMAS–FERMI MODEL. PART II. EXTENSION OF THE GREEN'S FUNCTION TECHNIQUE TO INCLUDE CORRELATION EFFECTS. Baraff, Gene A. New York; New York Univ. (1961). 83p. University Microfilms Order No. 72-24,467.

Thesis.

A systematic method is presented for deriving the Thomas–Fermi equation for an atom and the quantum corrections from the many-body description. The novel feature of the method is that it does not require any a priori assumptions about the distribution of the electrons in phase space but shows instead that the distribution usually assumed is a direct consequence of specifying that the many-particle system is in its ground state. The procedure used in the derivation is the expansion of the mixed position-momentum representation of the Green's function in a series of powers of $\hbar$. The lowest-order term is found to correspond with the Thomas–Fermi density. The form of the higher-order terms, which are to be considered as corrections to zeroth-order terms, depends on the approximations made in the many-body equations for obtaining the Green's function. This paper deals only with the Hartree–Fock approximation, but the methods presented here allow generalization to other approximations that can include correlation effects. (Diss. Abstr. Int., B)

1225 SOME INVESTIGATIONS INTO ATOMIC STRUCTURE. I. GROUND-STATE ENERGY OF LITHIUM. II. GROUND-STATE ENERGY OF ATOMS. Walsh, Peter J. New York; New York Univ. (1960). 90p. University Microfilms Order No. 72-24,553.

Thesis.

Description of atomic systems by introducing interelectron coordinates explicitly is treated. The simplest atomic systems, helium and lithium, are treated and excellent results are found in calculating the energy values of the corresponding ground states. In addition, an approximation technique of high accuracy was developed to handle, mathematically, wave functions containing many interelectron coordinates. Further the use of interelectron coordinates in constructing atomic wave functions was explored. A simple method is developed for constructing wave functions of this type, which yields surprisingly good values for the energy of a variety of atomic systems, in zero order. The hamiltonian for the system is split into an unperturbed part that is separable and contains the interelectron potentials as well as the electron–nucleus potentials and into a perturbing term that is always finite and vanishes whenever an electron is far from the nucleus. These zero-order energies corresponding to this splitting of the hamiltonian are at least an order of magnitude better for light atoms than the energies given by the usual Thomas–Fermi theory and are considerably better than the energies calculated with hydrogenic functions alone in first-order. (Diss. Abstr. Int., B)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

1226 INTERFACIAL PARAMETRIC ELECTROHYDRODYNAMICS OF INSULATING DIELECTRIC LIQUIDS. Jones, T. B. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys.; 43: No. 11, 4400-4(Nov 1972).

When a high-intensity electric field with a strong gradient, periodic in time, is imposed tangentially at the interface of an insulating dielectric fluid, parametric surface instability may result. Under typical conditions this instability grows to a certain amplitude, where nonlinear effects become dominant, resulting in a steady-state standing-wave pattern. In the linear small-amplitude limit, the surface dynamics are described by the Mathieu equation. The wavelength observed in the nonlinear amplitude-limited state is successfully correlated with the linear theory by determining the most unstable wavelength, that is, the wavelength with the maximum growth rate for given conditions of applied electric field strength and frequency. (auth)

1227 WEAK WAVES, CHARACTERISTICS, AND THE PROBLEM OF FLOW AROUND NARROW PROFILES IN ELECTROHYDRODYNAMICS. Gogosov, V. V.; Polyanskii, V. A. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 3, 137-46(1972). (In Russian).

The propagation of weak waves in electrodynamics in an undisturbed nonhomogeneous state is investigated. EHD flow past a thin profile is examined for shock waves of low intensity and for rarefaction waves. EHD supersonic flow in a constant electric field is described by a system of hyperbolic equations. (K.S.W.)

1228 SELF-SIMILAR NONSTEADY-STATE MGD FLOWS OF A RADIATING GAS INDUCED BY THE MOTION OF A PISTON. Mareev, V. A. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 3, 155-60(1972). (In Russian).

A fundamental investigation of the nonsteady-state gas flow in a duct induced by a piston motion, with MHD heat removal and luminescence of the gas, as previously conducted by Vatazhin (1970) was continued by the present author. For $R_m \ll 1$ and allowing for radiative effects there was found a class of self-similar solutions, conforming to a piston motion in accordance with a power law. Conditions were found for two self-similar problems under which acceleration or deceleration of the shock front occurred. (K.S.W.)

1229 ASYMPTOTIC NONLINEAR MAGNETOFLUIDDYNAMIC STABILITY IN MEDIA IN THE PRESENCE OF THE HALL EFFECT. Rionero, S. Ric. Mat.; 20: No. 2, 285-96(1971). (In Italian).

A unitary theorem developed earlier for the periodic or stationary movements in the absence of the Hall effect, based on the regular solutions of the equations of magnetofluiddynamics in the Boussinesq scheme, is extended to movements in the presence of the Hall effect. (J.S.R.)

1230 SEPARATING SELF-SIMILAR FLOW IN LAMINAR MHD BOUNDARY LAYERS DURING BLOWING AND SUCTION. Gotovtsev, A. V. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 3, 38-46(1972). (In Russian).

Self-similar flow in a MHD boundary layer was investigated for a pressure gradient, in injection and extraction of a conducting liquid. The region of existence of self-similar solutions was determined for the separating regime of flow characterized by null flow at the wall. The possibility of significant expansion of the region of nonseparating flows was demonstrated during the application of electric and magnetic fields. (K.S.W.)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 1283.

Electromagnetic

1231 (DNPL/P-136) TOTAL HADRONIC PHOTO-ABSORPTION CROSS SECTIONS OF NUCLEI FOR PHOTONS IN THE GeV ENERGY RANGE. Brookes, G. R.; Clough, A. S.; Freeland, J. H.; (and others) (Daresbury Nuclear Physics Lab. (England)). Aug 1972. 28p. Dep. NTIS (U. S. Sales Only).

The total hadronic photo-absorption cross sections of a number of nuclei (C, Al, Cu, Nb, Sn, Ta, Pb) were studied in detail using a tagged photon beam over the energy range 1.7 to 4 GeV. The results are described and compared with models of photo-absorption. (auth)

1232 (DNPL/P-138) ELECTROPRODUCTION OF $\pi^-\Delta^{++}(1236)$ FROM HYDROGEN AT W = 1.9 GeV AND $-k^2$ = 0.7 GeV^2. Montgomery, H. E.; Allison, J.; Dickinson, B.; (and others) (Daresbury Nuclear Physics Lab. (England)). Sep 1972. 20p. Dep. NTIS (U. S. Sales Only).

Cross sections are presented for the electroproduction of the channel $\pi^-\Delta^{++}(1236)$ from hydrogen, i.e., for the virtual photoproduction process $\gamma_V p - \pi^-\Delta^{++}(1236)$ at W = 1.9 GeV, $-k^2$ = 0.7 GeV^2 and with ϵ = 0.85 for ϕ = 90, 135, and 180° and 0.2 < $-t$ < 0.5 GeV^2 ($0 < \Theta^* < 45°$). Comparisons are shown with the Born model of Berends and Gastmans (Phys. Rev. D5, 204 (1972)) and with the vector dominance model of Bartl and Schildknecht (Nucl. Phys. B36, 28 (1972)). There is reasonable agreement between models and data except for the t-dependence of the Born model. (auth)

1233 PHOTOPRODUCTION OF A NEW VECTOR MESON BY LINEARLY POLARIZED 9.3 GeV GAMMA RAYS. Smadja, G. (Univ. of California, Berkeley); Bingham, H. H.; Fretter, W. B.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 349-68(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

From a 275 events/μb exposure of the 82'' HBC to the SLAC linearly polarized monochromatic (9.3 GeV) γ beam, a preliminary analysis shows evidence for peripheral [exp (6t)] photoproduction of a $J^P = 1^-$, meson with mass in the 1.5 GeV region, width $\gtrsim$0.4 GeV (M and Γ both model dependent) and $\sigma = 1.7 \pm 0.3$ μb in the reaction $\gamma p \to \rho' p$, $\rho' \to 2\pi^+2\pi^-$. The 4π system shows $\rho^0\pi^+\pi^-$ substructure. Arguments for $I^G = 1^+$ are presented from the angular correlations (and the lack of clear evidence for a $\rho^0\rho^0$ decay mode). (auth)

1234 REVIEW AND ANALYSIS OF LATEST DATA ON MEASUREMENTS OF FUNDAMENTAL PHYSICAL CONSTANTS. RATIO OF MAGNETIC MOMENT OF PROTON TO NUCLEAR MAGNETON. Kholin, V. M. Meas. Tech. (USSR) (Engl. Transl.); 15: No. 3, 364-8(Mar 1972).

Translated from Izmer. Tekh.; 15: No. 3, 14-16(Mar 1972).

Latest data on the ratio of the magnetic moment of the proton to the nuclear magneton is reviewed. The value obtained is 2.7927745 ± 0.0000012. This measured value is close to the value calculated from all preceding measurements but is more accurate and this constant is one of the fundamental constants that is known most exactly. (F.S.)

1235 PHOTOPRODUCTION OF ρ^0 ON HYDROGEN WITH TAGGED PHOTONS BETWEEN 4 AND 6 GeV. Struczinski, W. (Technische Hochschule, Aachen); Dittmann, P.; Eckardt, V.; (and others). Nucl. Phys.; B47: No. 2, 436-44(1972).

The reaction $\gamma p \to p\pi^+\pi^-$ was measured in the DESY 1 m streamer chamber. The dominant ρ^0 production is analyzed in terms of various models. (auth)

1236 π^- PHOTOPRODUCTION FROM DEUTERIUM AND A PARTIAL WAVE ANALYSIS OF π^+ AND π^- PHOTOPRODUCTION IN THE ENERGY REGION 500 TO 1250 MeV. Scheffler, Paul Erick. Pasadena, Calif.; California Inst. of Tech. (1972). 309p. University Microfilms Order No. 72-22,558.

Thesis.

Single π^+ and π^- photoproduction rates from deuterium were measured at the Caltech 1.5 GeV electron synchrotron at 32 photon energies between 585 and 1250 MeV and for 13 CM pion angles between 6 and 160° at each energy. The cross section for the reaction $\gamma n \to \pi^- p$ was calculated via the π^-/π^+ ratio from deuterium and via the spectator model for the deuteron. A partial wave analysis was done on the reactions $\gamma p \to \pi^+ n$ and $\gamma n \to \pi^- p$ in the region of the second and third photoproduction resonances using the model of R. L. Walker. The results show some disagreements with recent quark theories. A case is made for the possibility that the S_{11} (1535) is excited by isoscalar photons, in agreement with some results of η photoproduction experiments, and in disagreement with quark theory. Finally, the helicity-$\frac{3}{2}$ component of the F_{15}(1688) resonance in π^- photoproduction is seen to be small, but not zero as predicted by the quark model. (Diss. Abstr. Int., B)

1237 EXPERIMENTAL STUDY OF THE TWO-PHOTON DECAYS OF THE NEUTRAL K MESONS. Shochet, Melvyn Jay. Princeton, N. J.; Princeton Univ. (1972). 122p. University Microfilms Order No. 72-24,702.

Thesis.

The two-photon decays of the neutral K mesons were studied in an experiment performed at the Brookhaven A.G.S. The apparatus was triggered on neutral decays from a K_L^0 beam 200 feet from a target and from K_L^0's and K_S^0's just downstream of a uranium regenerator. The vector momentum of one γ-ray was measured in a pair spectrometer, while the trajectory of the other γ-ray was recorded in a 5-radiation-length shower chamber. Normalization for the $K_L^0 \to \gamma\gamma$ branching ratio was obtained from reconstructed $K_L^0 \to \pi^0\pi^0$ decays, while $K_L^0 \to \gamma\gamma$ decays downstream from the regenerator served as normalization for the $K_S^0 \to \gamma\gamma$ measurement. The branching ratio for $K_L^0 \to \gamma\gamma$ was found to be $(4.32 \pm 0.55) \times 10^{-4} \times |\eta_{+-}/\eta_{\pm}|^2$. The branching ratio for $K_S^0 \to \gamma\gamma$ was found to be $(-1.95 \pm 2.36) \times 10^{-4}$, corresponding to a 90% confidence level $BR(K_S^0 \to \gamma\gamma) < 1.1 \times 10^{-4}$. This result assumes no interference between $K_L^0 \to \gamma\gamma$ and $K_S^0 \to \gamma\gamma$. (Diss. Abstr. Int., B)

1238 MEASUREMENT OF MUON-PAIR PHOTOPRODUCTION IN THE DEEP INELASTIC REGION. Davis, J. F.; Hayes, S.; Imlay, R.; Stein, P. C.; Wanderer, P. J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 29: No. 19, 1356-9(6 Nov 1972).

The inclusive cross section for low-mass muon pair photoproduction was measured in the deep inelastic region. The measured cross section is much larger than that expected for one-photon (Bethe–Heitler) processes. This result may be additional evidence for pointlike structure (partons) in nucleons. The experimental results are compared with the parton model of Bjorken and Paschos. The value of the cross section predicted by this model is too low. (auth)

1239 OBSERVATION OF A FOUR-PION VECTOR-MESON STATE OF MASS ~ 1.5 GeV PRODUCED BY LINEARLY POLARIZED 9.3-GeV PHOTONS. Bingham, H. H. (Univ. of California, Berkeley); Fretter, W. B.; Podolsky, W. J.; (and others). Phys. Lett.; 41B: No. 5, 635-8(30 Oct 1972).

From a study of $\gamma p \to 2\pi^+2\pi^- p$ using 9.3 GeV linearly polarized photons, evidence is found for a $J^P = 1^-$, $I^G = 1^+$ four pion enhancement of mass ~ 1.5 GeV with a production cross section of 1.6 ± 0.4 μb. (auth)

1240 MESON PHOTOPRODUCTION. Luebelsmeyer, K. (Univ., Bonn). pp 296-354 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A summary of new results for meson photoproduction is given with restrictions to experiments above the s-channel resonance region. A tabulated summary of work in the resonance region is presented. Pseudoscalar and vector meson photoproduction, total photon cross sections, and Compton scattering are covered. (J.F.P.)

Weak

Refer also to abstracts 1427 and 1547.

1241 STUDY OF THE FORM FACTOR IN $K^0 \to \pi\nu$ DECAYS. Nuehofer, G. (CERN, Geneva); Niebergall, F.; Regler, M.; (and others). Phys. Lett.; 41B: No. 5, 642-6(30 Oct 1972).

The vector form factor $f_+(t)$ was studied with 1910 kinematic fully reconstructed events $K^0 \to \pi e\nu$; assuming a linear dependence of $f_+(t)$, where $f_+(t) = f_+(0)\ (1 + \lambda_+ t/m_\pi^2)$, the result $\lambda_+ = 0.022 \pm$

0.014 was obtained. Data at large values of t are found to be subject to a singularity in resolution, whose influence on λ_+ is demonstrated; the possible implications for previous experiments are discussed. (auth)

1242 STUDY OF THE STRONG INTERACTION FORM FACTORS FOR $K_L^0 \to \pi\mu\nu$ AND $K_L^0 \to \pi\nu$. Dally, E. (Stanford Linear Accelerator Center, Calif.); Innocenti, P.; Seppi, E.; (and others). Phys. Lett.; 41B: No. 5, 647-51(30 Oct 1972).

The strong interaction form factors were extracted from K_{e3}^0 and $K_{\mu3}^0$ data of the previously reported K_L^0 experiment in a manner which does not assume an explicit $q^2 = (p_K - p_\pi)^2$ dependence. The unparameterized form factors $f_+(q^2)$ from the $K_L^0 \to \pi e\nu$ and $K_L^0 \to \pi\mu\nu$ modes and $f_0(q^2)$ and $\xi(q^2)$ from the $K_L^0 \to \pi\mu\nu$ data are presented. A comparison of these unparameterized results is made with the results of the Dalitz plot analyses. (auth)

1243 HIGH-ENERGY MUOPRODUCTION AND VECTOR-DOMINANCE MODEL. Michel, B.; Montret, J. C. (Univ., Clermont, France). Nuovo Cim.; 11A: No. 4, 1015-22(21 Oct 1972).

Muon–nucleon inelastic scattering at high energy and low momentum transfer, induced by 6- and 12-GeV incoming muons in nuclear emulsions is studied. The experimental cross sections are analyzed by means of the vector-dominance model. Also a comparison is established between the values of the cross section and similar measurements of Dieterle et al. Finally a theoretical fit of these results, using the rho-dominance model, is realized. (auth)

Strong (Baryon-induced)

Refer also to abstract 1337.

1244 (COO-3330-4) EXPERIMENTAL STUDY OF $\bar{p}p \to K_S^0 K_S^0$ IN THE MOMENTUM RANGE 300 TO 750 MeV/c. Carson, R. G.; Button-Shafer, J.; Hertzbach, S. S.; Kofler, R. R. (Massachusetts Univ., Amherst); Yamamoto, S. S. (Tokyo Univ. (Japan)). 1972. 10p. (CONF-720923-2). Dep. NTIS.

From sixteenth international conference on high energy physics; Chicago, IL. (6 Sep 1972).

The cross sections and angular distributions are studied for the reaction $\bar{p} + p \to K_1^0 + K_2^0$ at 350 to 750 MeV/c in hydrogen bubble chamber. No clear evidence for a resonant S meson state was found. (J.F.P.)

1245 (UCI-34-P-149-X-1) HIGH ENERGY USER GROUP, Appendix A, Progress Report. (California Univ., Irvine). 1972. Contract AT(04-3)-34, 8p. Dep. NTIS.

Progress is reported on research conducted by the High Energy Physics Group of the University of California, Irvine during the contract year beginning October 1, 1971. The measurement of $\bar{p}p$ film is completed and the status of analysis of various reaction channels is reported. Status of measurement and analysis of $\bar{p}d$ film is reported. Three new experiments are discussed and a description is given of the status of the groups' data acquisition and computing systems. (auth)

1246 DIRECT CHANNEL AND U MESON FORMATION IN $\bar{p}p$ INTERACTIONS. Cohen, K. J. (Rutgers–The State Univ., New Brunswick, N. J.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 242-68(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The broad bumps observed in $\sigma_{TOT}(\bar{p}p)$ in the region of the T and the U mesons have been investigated with the Rutgers Annihilation Spectrometer (RAS). This spectrometer measures 32 independent mass spectra simultaneously. The spectra are parametrized by charged multiplicity (8 possibilities) and the angular region of the most forward going particle in the final state (4 regions measured). The mass resolution is ±5 MeV and seven incident momenta are measured simultaneously. The results are in agreement with previous measurements of $\sigma_{TOT}(\bar{p}p)$. The observed structures are ~2% above the background. The angular dependence and the multiplicity dependence are presented for the background and for the structure. (auth)

1247 HIGH STATISTICS MISSING MASS SPECTROSCOPY IN THE REACTIONS $d + p \to {}^3He + (MM)^0$ AND $d + p \to {}^3H + (MM)^+$ BETWEEN 2.8 AND 3.8 GeV/c. Banaigs, J. (CNRS, Saclay, France); Berger, J.; Goldzahl, L.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 369-78(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The ABC effect and structure in the neighborhood of 460 MeV were studied in the missing mass spectra from the reactions $d + p \to {}^3He + (mm)^0$ and $d + p \to {}^3H + (mm)^+$ as a function of the incident deuteron momentum and the laboratory angle of the recoiling nuclei. Data were also obtained on the reaction $N + p \to d + (mm)^{0+}$ with nucleons having one half of the incident deuteron momentum. (auth)

1248 MEASUREMENT OF THE Ξ HYPERON LIFETIMES AND α PARAMETERS. Mayeur, C. (Univ. Libre, Brussels); Van Binst, P.; Wilquet, G.; (and others). Nucl. Phys.; B47: No. 2, 333-47(1972).

In an experiment using a heavy liquid bubble chamber the Ξ hyperon lifetimes and α parameters were measured to be $\tau_{\Xi^0} = (3.04 \pm {}^{0.36}_{0.28}) \times 10^{-10}$ sec, $\tau_{\Xi^-} = (1.73 \pm {}^{0.09}_{0.07}) \times 10^{-10}$ sec, $\alpha_{\Xi^0} = -0.84 \pm 0.27$ and $\alpha_{\Xi^-} = -0.42 \pm 0.11$. These values agree with measurements which employed different techniques and are consistent with the predictions of the $\Delta I = \frac{1}{2}$ rule. (auth)

1249 ELASTIC pp-SCATTERING IN THE COULOMB INTERFERENCE REGION IN THE MOMENTUM RANGE 1.1 TO 1.7 GeV/c. Vorob'ev, A. A.; Denisov, A. S.; Zalite, Yu. K.; (and others) (Inst. of Nuclear Physics, Leningrad). Phys. Lett.; 41B: No. 5, 639-41(30 Oct 1972).

Differential cross sections for pp elastic scattering in the transfer momentum range $2 \times 10^{-3} \leq |t| \leq 8 \times 10^{-3}$ (GeV/c)^2 were studied with a hydrogen filled ionization chamber which was used as a target and as a detector of the recoiled protons. The measurements were done at $P_{lab.} = 1.11$ GeV/c, 1.28 GeV/c, 1.34 GeV/c, 1.40 GeV/c and 1.70 GeV/c. The real part of the spin independent forward scattering amplitude was determined, the results being in agreement with the dispersion relation calculations. (auth)

1250 THERMODYNAMIC INCLUSIVE SINGLE-PARTICLE SPECTRA AND PARTICLE PRODUCTION RATIOS AT THE ISR. Ranft, J. (CERN, Geneva). Phys. Lett.; 41B: No. 5, 613-17 (30 Oct 1972).

Two essential modifications of the thermodynamic single particle spectra using fireballs according to the strong bootstrap model are described: (i) An energy-dependent velocity weight function is introduced which leads to better agreement with the flat single particle spectra in the central region observed at the ISR. (ii) Heavy pair production is modified by producing the two particles in different steps of the decay chain of the fireballs. The fact that heavy fireballs are produced leads in the model to a natural understanding of the deviations from scaling behavior in the central region of single particle spectra $p + p \to \pi^\pm$, $\bar{p}$ or K^- + anything between 20 GeV and ISR energies. The particle production ratios $\bar{p}/\pi^-$, K^-/π^-, π^+/p, K^+/p and $\bar{p}/p$ are compared to recent ISR data. (auth)

1251 MULTIPLE PRODUCTION AND PROCESSES AT ULTRA HIGH ENERGIES. Wroblewski, A. (Univ., Warsaw). pp 42-94 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The review of multiple production and processes at ultrahigh energies covers cross sections, multiplicities, single particle distributions, resonance production, correlations, comparison with models, and reactions with nuclei. (J.F.P.)

1252 NONSTRANGE BARYON RESONANCES. Plano, R. (Rutgers–The State Univ., New Brunswick, N. J.). pp 148-86 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The experimental status of the nucleon resonances is discussed from the viewpoints of formation and production experiments. It is noted that a large amount of detailed and difficult experimental data gathering and analysis was carried out which has improved and sharpened previous numbers and conclusions. (J.F.P.)

1253 STRANGE BARYON RESONANCES. Samios, N. (Brookhaven National Lab., Upton, N. Y.). pp 187-218 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The experimental situation for strange baryon resonances is summarized. The existence of Z* states, the properties and existence of Λ and Σ states, Ξ states, and the classification of the more well-established states into SU(3) multiplets and an examination of the Regge recurrence of such resonances are discussed. (J.F.P.)

1254 p–p AND p–d SCATTERING AT SMALL ANGLES IN THE RANGE OF 8 TO 70 GeV. Nikitin, V. A. (Joint Inst. for

Nuclear Research, Dubna, USSR). pp 355-9 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The differential cross sections for elastic p + p and p + d interactions were measured at 8 to 70 GeV in the momentum transfer range of 0.001 to 0.080 $(GeV/c)^2$. The real part of the amplitudes for these interactions was determined using the Bethe formula without spin dependent terms. Also the total cross section which determines the optical point was calculated from an extrapolation formula. (J.F.P.)

Strong (Meson-induced)

Refer also to abstract 1338.

1255 (JINR-P1-6624) MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS OF THE INVERSE PION ELECTROPRODUCTION REACTION ($\pi^-p \to e^+e^-n$) NEAR THE $\Delta(1236)$ RESONANCE. Berezhnev, S. F.; Dem'yanov, A. V.; Kulikov, A. V.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The reaction of the inverse pion electroproduction $\pi^-p \to e^+e^-n$ was studied at a 276 MeV pion kinetic energy. Electrons and positrons were detected by two telescopes consisting of scintillation and Čerenkov counters, total absorption Čerenkov spectrometers and spark chambers having a charge along the track. Both the spectrometers were fixed at the angle of 90° with respect to the pion beam. The production of the effective solid angles $\Omega_1 \cdot \Omega_2$ was 0.37 sr^2. There was 1.56 g/cm^2 of liquid hydrogen along the beam direction. The muster pulse was generated at the coincidence of pulses from all the detectors provided the sum of energies released in both spectrometers exceeded 170 MeV. Tracks in spark chambers were photographed. To obtain pulse-height distributions in scintillation counters and Čerenkov spectrometers and time-of-flight distributions of pulses from scintillation counters the pulses from these counters were fed on-line to the computer. Data processing has yielded 226 ± 31 events of the reaction under investigation. The missing mass distribution of the events (Fig. 2a) has a prominent peak in the region of neutron mass. The missing mass distribution of background events is shown in Fig. 2b. The procedure of subtracting background events was based on the fact that background events are characterized by greater ionization losses than events of the reaction under study. The differential cross section of the reaction for the electrons with energies of E_1 and $E_2 > 60$ MeV emitted at angles close to 90° with respect to the pion beam is: $(d^2\delta/d\Omega_1 d\Omega_2) = (4.0 \pm 0.6)$ 10^{-33} cm^2/sr^2. Event distributions versus four different kinematic variables are given. (auth)

1256 (LBL-736) STUDY OF THE REACTION $K^+p \to \pi^+pK^0$ AT 12 GeV/c AND A TEST OF THE GENERALIZED VENEZIANO MODEL AT 4.6, 9, AND 12 GeV/c. Waluch, V. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jun 1972. Contract W-7405-eng-48. 96p. Dep. NTIS.

Thesis.

Data on the reaction $K^+p \to \pi^+pK^0$ at 12 GeV/c and a study of the generalized Veneziano model at 4.6, 9, and 12 GeV/c are presented. The $K^0\pi^+$ mass spectrum was studied and it was found that in addition to the K*(890) and K*(1420) resonances, there is a hint of a resonance at 1.8 GeV, but one was unable to measure its parameters. The differential cross sections, the total cross sections, the masses and widths, and the spin density matrices of the two K* and the $\Delta(1236)$ resonances were measured, and found to be in agreement with previously published data. The generalized Veneziano model was fitted to our reaction and to data at the other energies. It was found that the five parameters used in the theory do not significantly change with energy. The fits at all energies are quite good. However, difficulties with the model at one energy persist at all energies. In particular, it is found that the model fits the mass spectra very well at all energies, that the momentum transfer distributions to the single particles and to the resonances fit well, and that the ratio of the cross sections of resonances in a given channel are well predicted by the model. The model's inability to fit the $p\pi^+$ mass spectrum is evident at all energies. (auth)

1257 (RPP/H-102) TWO BODY FINAL STATES IN K^-p INTERACTIONS AT 14.3 GeV/c. Miller, R. J.; Paler, K.; Phelan, J. J.; (and others) (Rutherford High Energy Lab., Chilton (England)). 1972. 13p. Dep. NTIS (U. S. Sales Only).

Differential and total cross sections for 14.3 GeV/c K^-p interactions are presented for the $n\bar{K}^0$, $\Lambda\pi^0$, $\Sigma^+\pi^-$ and $\Sigma^+(1385)\pi^-$ final states. Measurements of the average values of the Λ and Σ^+ polarizations and of the $\Sigma^+(1385)$ density matrix elements are also given. In addition, total cross sections were measured for the $\bar{K}^0\Delta^0$, $\Lambda\eta$, $\Lambda\eta'(958)$, $\Lambda\rho$, $\Lambda\omega$, and $\Lambda\phi$ reactions. (auth)

1258 $\pi\pi$ PHASE-SHIFT ANALYSIS FROM AN EXPERIMENT $\pi^-p \to \pi^-\pi^+n$ AT 17.2 GeV/c. Grayer, G. (CERN, Geneva); Hyams, B.; Jones, C.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 5-16(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The $\pi\pi$ phase-shifts were determined by a Chew-Low extrapolation in the $\pi\pi$ mass region from 500 to 1500 MeV using data of a spark chamber experiment on $\pi^-p \to \pi^-\pi^+n$ at 17.2 GeV/c, which yielded 318,000 events. An I = 0 s-wave phase shift is found which increases slowly, passing through 90° near 900 MeV, and then rises very rapidly. The old "up" solution is eliminated on the basis of fits in the mass region from 900 to 1000 MeV. (auth)

1259 MESON MASS SPECTRUM NEAR THE $X^0(958)$. Binnie, D. M. (Imperial Coll. of Science and Tech., London); Camilleri, L.; Duane, A.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 139-46(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The meson spectrum near the $\eta'(958)$ is studied in the reaction $\pi^-p \to nX^0$ near threshold. Only the η' is seen. A mass of 957.1 ± .45 MeV and a width <1.9 MeV (95% CL) is found. (auth)

1260 REVIEW OF THE RESULTS OBTAINED BY THE BOLOGNA-CERN MULTIPURPOSE NBC SET-UP. Basile, M.; Bollini, D.; Buhler-Broglin, A.; (and others) (CERN, Geneva). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 147-62(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The Bologna-CERN multipurpose NBC setup has allowed a systematic study of some intrinsic properties of the η, S^0, ρ, ω, X^0, ϕ, and A_2^0 mesons. These are presented in a synthetic way. (auth)

1261 A_1 AND A_2 PRODUCTION AT 40 GeV/c. Antipov, Yu. M. (Inst. of High-Energy Physics, Serpukhov, USSR); Ascoli, G.; Busnello, R.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 164-83(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The reaction $\pi^-p \to \pi^-\pi^-\pi^+p$ was investigated at 40 GeV/c incident momentum in the momentum transfer interval $0.04 < t < 0.33$ $(GeV/c)^2$. Analyzing the decay of the 3π system by a partial-wave method, the parameters, the differential cross section, and the polarization of the abundantly produced A_1 and A_2 mesons are obtained. From the interference between the different partial waves, a resonance behavior is found for the A_2 meson but not for the A_1 meson. (auth)

1262 MEASUREMENTS OF MISSING MASS (MM) SPECTRA FROM $\pi^-p \to (MM)^-p$ AT 8, 11, 13.5, AND 16 GeV. Bowen, D. (Northeastern Univ., Boston); Earles, D.; Faissler, W.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 215-40(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

Measurements of missing mass (MM) spectra from $\pi^-p \to (MM)^-p$ at 8, 11, 13.5, and 16 GeV are reported. The MM mass range examined is $0 \le M^2 \le 7.3$ GeV^2 with t (the proton four momentum transfer squared) in the interval $0.2 \le |t| \le 0.3$ GeV^2. Narrow resonances (R_1, R_2, R_3, S, T, and U) with cross sections and widths reported by the CERN missing mass group are ruled out by the data. The cross sections $d^2\sigma/dtdM^2$ show evidence for triple factorizability of the form $d^2\sigma/dtdM^2 \simeq D(P_B)A(M^2)G(P_T^2)$ where P_B is the incident beam momentum, and P_T^2 is the perpendicular component of the detected proton's momentum with respect to the beam direction. (auth)

1263 STUDY OF THE $\eta\pi$ MASS SPECTRUM PRODUCED IN $\pi^-p \to \eta\pi^-p$ INTERACTIONS AT 6 GeV/c. Prepost, R. (Univ. of Wisconsin, Madison); Tompkins, D. H.; Witherell, M. S.; (and others). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 879-80 (1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

An optical spark chamber experiment was performed to study the reaction $\pi^-p \to X^-p$, $X^- \to \eta\pi^-$, $\eta \to \gamma\gamma$ for X^- masses from threshold to 1.5 GeV/c^2. Preliminary results on the $\eta\pi$ mass

spectrum in the A_2 region produced at a beam momentum of 6 GeV/c are presented. (L.B.S.)

1264 OBSERVATION OF A BACKWARD PRODUCED Q IN K^+p INTERACTIONS. Firestone, A. (California Inst. of Tech., Pasadena). Nucl. Phys.; B47: No. 2, 348-54(1972).

The observation of the Q enhancement produced in the backward direction in the reaction $K^+p \rightarrow pQ^+$, $Q^+ \rightarrow K^+\pi^+\pi^-$ is reported. The energy dependence for this reaction is given by $\sigma(s) \sim s^{2\alpha-2}$ where $\alpha = -1.1 \pm 0.1$. The shape of the Q appears very similar to that observed in the forward diffractive reaction. The differential cross section is given by $d\sigma/d\mu' \sim e^{-5.8\mu'}$. (auth)

1265 THREE BODY CROSS SECTIONS IN K^-p INTERACTIONS AT 1670 MeV. Snow, Thomas Russell. Durham, N. C.; Duke Univ. (1972). 95p. University Microfilms Order No. 72-23,256.

Thesis.

The cross sections for the reactions: $K^-p \rightarrow K^-p\,\pi^0$, $K^-p \rightarrow K^-\pi^+n^0$, $K^-p \rightarrow \Sigma^+\pi^-\pi^0$, $K^-p \rightarrow \Sigma^-\pi^+\pi^0$, $K^-p \rightarrow \Sigma^0\pi^+\pi^-$, and $K^-p \rightarrow \Lambda\,\pi^+\pi^-$ are presented as part of the study of K^-p interactions at a center of mass energy near 1670 MeV. In addition, the processes for the three body production were investigated. The processes considered were the quasi two body mode, e.g., $K^-p \rightarrow Y^0\pi \rightarrow \Lambda\pi$, and pure phase space production. Because of the paucity of the data for the reactions $K^-p \rightarrow K^-p\,\pi^0$ and $K^-p \rightarrow K^-\,\pi^+n$, no attempt was made to determine the production process involved. Examining the invariant mass distributions for the $\Sigma\pi\pi$ final states indicated little or no $Y_0^*(1405)$ or $Y_1^*(1385)$ production, nor was the data consistent with pure phase space production. The exact nature of the production of the $\Sigma\pi\pi$ final states was not determined. The $K^-p \rightarrow \Lambda\pi^+\pi^-$ reaction was found to proceed almost entirely via the quasi two body process $K^-p \rightarrow Y_1^*(1385)^{\pm}\pi^{\mp} \rightarrow \Lambda\pi^{\pm}$. In an attempt to determine the $Y_1^*(1385)$ branching fraction $R[\Gamma(Y_1^* \rightarrow \Sigma^0\,\pi^{\pm})/\Gamma(Y_1^* \rightarrow \Sigma^0\,\pi^{\pm}) + \Gamma(Y_1^* \rightarrow \Lambda\,\pi^{\pm})]$, various models were fit to the $M(\Sigma^0\,\pi^{\pm})$ distributions. None of these successfully reproduced the data. Therefore, it was impossible to determine even a reasonable upper limit for the Y_1^* branching ratio. (Diss. Abstr. Int., B)

1266 PRODUCTION OF SIX CHARGED PARTICLES IN π^-p INTERACTIONS AT 7 GeV/c. Berenyi, Peter Louis. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

Events with six charged particles produced in a hydrogen bubble chamber by a 6.95-GeV/c π^- beam are analyzed. The 330,000 picture exposure yielded over 4000 events belonging to the fitted channels $\pi^-p \rightarrow p2\pi^+3\pi^-(\pi^0)$ and $\pi^-p \rightarrow 3\pi^+3\pi^-n$. In the $\pi^-p \rightarrow p2\pi^+3\pi^-$ channel strong production of ρ^0 and Δ^{++} is observed. The A_1^- and A_2^- mesons are also produced. The center of mass opening angles between pion pairs are presented and the differences between like and unlike pion pairs are shown to agree with the Goldhaber model predictions. In the $\pi^-p \rightarrow p2\pi^+3\pi^-\pi^0$ channel the Δ^{++}, ω^0, η^0 and X^0 resonances are observed. There is also evidence for the $D^0 \rightarrow \eta^0\pi^+\pi^-$ decay. The pseudo five body state $p\pi^+2\pi^-\omega^0$ is compared with the predictions of a modified Reggeized multiperipheral model. The X^0 and D^0 are shown to originate mainly from pseudo three body states $p\pi^-X^0$ or D^0. Single particle distributions from all fitted states are also presented and are compared with the predictions of phase space and two phenomenological models. (Diss. Abstr. Int., B)

1267 EXPERIMENTAL STUDY OF π^-p CHARGE EXCHANGE SCATTERING AT 180° FROM 1.8 TO 6.0 GeV/c. Meyers III, Arthur Christian. St. Louis; St. Louis Univ. (1972). 301p. University Microfilms Order No. 72-23, 973.

Thesis.

The cross section for 180° π^-p charge exchange scattering was measured for incident π^- momenta in the range from 1.8 to 6.0 GeV/c in 52 approximately equally spaced momentum steps. Statistical errors were typically ±5%. The experiment was done in the 17° π^- beam of the ZGS at Argonne National Laboratory using arrays of scintillation counters. Both the neutron and the two photons from the π^0 were detected in counters made by sandwiching layers of lead and scintillator. The detection efficiencies of the neutron and photon counters were experimentally determined. A ring of 24 shower counters whose axis was on the beam line was located 90 cm upstream and was shielded from the liquid hydrogen target by a charged particle anticounter. The complete forward hemisphere was shielded by a charged and neutral particle anticounter except for a hole at zero degrees for the neutron. The neutron counter located downstream from the liquid hydrogen target was shielded by a photon and charged particle anticounter. Nanosecond logic was used to determine coincidences. The coincidence requirements for a charge exchange event were two or more of the 24 ring counters in coincidence with a beam particle and with no veto signal. The presence (or absence) of a signal from the neutron counter in coincidence with the ring counters and beam was also recorded. The data were analyzed for both cases and the cross sections were found to agree within statistical error. Extensive analysis for possible multipion contamination shows that such background is negligible. The cross sections $(d\sigma/d\Omega)_{CM}$ and $(d\sigma/du)_{CM}$ are given in tabular form for all 52 momenta. Existing data from 180° π^-p and π^-p elastic scattering were used with the results of this experiment to calculate the magnitude of the A_s and A_u amplitudes and their relative phase as a function of incident pion momentum. These results were plotted for both the s and u channels. This analysis was not possible before the results of this experiment were available and it provides direct experimental support for charge independence. The cross section was compared with predictions from the Barger and Cline model. The data are shown to fit a modified Veneziano-Igi model with a $\chi^2 = 79$ for the 52 points. Above 4 GeV/c, the cross section decreases smoothly, within uncertainties, and can be fitted with an exponential. The kinematics and all published momentum measurements at 180° for π^+p are derived, and π^-p elastic and charge exchange scattering are listed. (Diss. Abstr. Int., B)

1268 DIP STRUCTURES IN $\pi^+ + p \rightarrow \rho^+ + p$ AT 1.55 TO 1.84 GeV/c. Williamson, Y. (Univ. of California, Riverside); Fung, S. Y.; Kernan, A.; (and others). Phys. Rev. Lett.; 29: No. 19, 1353-6(6 Nov 1972).

Results of a high-statistics study of $\pi^+ + p \rightarrow \rho^+ + p$ at 1.55 to 1.84 GeV/c are consistent with dominance of π and ω exchange close to threshold. A pronounced dip in $\rho_{00}^5\, d\sigma/dt$ at $-t \simeq 0.4$ GeV^2 may be attributed to pion exchange with strong absorption. (auth)

1269 TWO-BODY HADRONIC INTERACTIONS AND TOTAL CROSS SECTIONS. Allaby, J. V. (CERN, Geneva). pp 11-40 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review is given of two-body strong interactions and total cross sections covering forward elastic and charge-exchange scattering, backward scattering, large-angle elastic scattering, structure in differential cross sections, polarization in high energy scattering, inelastic two-body reactions, total cross sections, and K^0 regeneration. (J.F.P.)

1270 BOSON RESONANCES. Astier, A. (College de France, Paris). pp 95-147 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

In the discussion of boson resonances $\pi\pi$, $\bar{K}K$, and $K\pi$ interactions, study of effective mass distributions particularly by the matrix element techniques for bubble chamber work, results of the missing-mass spectrometer experiments $\bar{N}N$ cross section bumps, and electromagnetic decays are reviewed. (J.F.P.)

1271 ENERGY DEPENDENCE OF π^-, K^-, AND $\bar{p}$ TOTAL CROSS SECTIONS OF PROTONS IN THE MOMENTUM RANGE UP TO 65 GeV/c. Vasiliev, L. M.; Gorin, Yu. P.; Denisov, S. P.; (and others) (Inst. of Herontology and Experimental Pathology, Serpukhov, USSR). pp 360-4 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

Preliminary data are presented on the total cross section energy dependence in the momentum range up to 6r GeV/c for π^- + p, K^- + p, and $\bar{p}$ + p interactions. A liquid hydrogen target and a new high resolution differential Cherenkov counter were used. (J.F.P.)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 1910.

1272 ELEMENTARY PROCESSES AT HIGH ENERGY. PART A. Ettore Majorana International Centre for Scientific Culture 1970 International School of Subnuclear Physics, Erice, Italy, July 1–19, 1970. Zichichi, A. (ed.). New York; Academic Press Inc. (1971). 463p. $29.50.

Eleven lectures are presented; a separate abstract was prepared for each lecture. (L.B.S.)

For abstracts of individual lectures see: 1288–1290, 1314, 1321–1323, 1380, 1402, 1431, and 1432.

General

Refer also to abstract 1444.

1273 PRODUCTION OF SPIN J RESONANCE IN A DUAL RESONANCE MODEL. Laperashvili, L. V.; Safro, M. G. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 15: No. 5, 1020-7 (May 1972). (In Russian).

The amplitudes and the asymptotic cross sections for the S + S → S + $X^{(J)}$ process, where S is a scalar particle and $X^{(J)}$ is a spin J resonance which lies at the S particle-trajectory are calculated. The group-theoretical method of construction of dual spin multipoint diagrams was used. The differential cross sections are shown to decrease with increasing of J as exp ((1 – 2 ln 2)J) at the asymptotic values of the energy. (auth)

1274 MODEL-INDEPENDENT ANALYSIS OF DENSITY-MATRIX ELEMENT MEASUREMENTS IN MULTIPARTICLE REACTIONS. Ader, J. P.; Meyers, C.; Salin, Ph. (Univ., Bordeaux). Nucl. Phys.; B47: No. 2, 397-421(1972).

A general study of polarization measurement in multiparticle production processes is presented including a definition of experimentally observable quantities, the splitting into natural- and unnatural parity exchanges and a study of their relative phase, and information concerning the quantum numbers of a packet of particles. When only one single particle is detected in the final state (inclusive reactions for instance) it is proven that the usual formalism for two-body reactions is applicable. Very interesting new information on multi-particle production can be reached when it can be asserted that another particle was emitted above or below a given plane, parallel or perpendicular to the scattering plane. (auth)

1275 RECURRENCE FORMULA FOR THE VENEZIANO MODEL N-POINT FUNCTIONS. Mano, Koichi (Air Force Cambridge Research Labs., Bedford, Mass.). J. Math. Phys.; 13: No. 10, 1525-6(Oct 1972).

A recurrence formula is derived for a function which reduces to the Veneziano model (n + 3)-point function. It is shown that the formula is equivalent to, but is more self-contained than, the Hopkinson and Plahte formula in that it does not require the prescription for the parameters involved. (auth)

1276 FORM FACTORS FOR ANY SPIN AND CHARGE COUPLING. Tchrakian, D. H. (Univ. of Sussex, Falmer, Eng.). J. Math. Phys.; 13: No. 10, 1477-84(Oct 1972).

A prescription for decomposition into form factors of the matrix elements of totally symmetric tensor currents between (s,0) and (s',0) spinor states of the incoming and outgoing particles of spin s and s' is presented. The case of the electromagnetic current is studied in some detail, and procedure to modify the above prescription resulting in the grouping of the form factors into Dirac-type and Pauli-type classes is given. Several examples are used for illustration. (auth)

1277 OPERATOR FORMALISM FOR THE DUAL-POSITION-SPACE KERNELS IN DUAL-RESONANCE THEORY. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 633-57(Aug 1972).

Operator versions of the Koba-Nielsen kernels represented in terms of the dual four-positions are given in two ways: One is with the use of quantum mechanics associated with a two-dimensional domain of rectangular type (string × "time") and the other is the usual operator formalism for the sake of comparison. The interplay of the composition law and the "factorization" is also displayed in this formulation. It is also suggested that the functional field and the functional propagator together with the functional equations they satisfy, are also definable in dual-position space almost identical to the Fourier transforms of the functional field and the propagator in position space. (auth)

1278 UNITARITY EQUATION FOR QUASI-ELASTIC REACTIONS. Alvarez-Estrada, R. F.; Carreras, B.; Gomez, J. L. Sanchez (Univ., Madrid). Progr. Theor. Phys. (Kyoto); 48: No. 2, 658-61(Aug 1972).

The unitarity equation for "quasi-elastic" reactions A + B → C + B below the production threshold is studied as a nonlinear integral equation to get the phase of the amplitude from the differential cross section. (auth)

1279 NOTE ON THE LOCAL GAUGE PRINCIPLE IN CONFORMAL DUAL MODELS. Yoneya, Tamiaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 48: No. 2, 616-24(Aug 1972).

The problem of the appearance of massless spin-one particles ("photons") in conformal dual models is discussed from the point of view of the local gauge principle. In three representative examples of the conformal dual models, it is shown how such "photons" are interpreted as the gauge boson associated with a local gauge transformation of the master wave function. (auth)

1280 TACHYONS AND THE ARROW OF CAUSALITY. Rolnick, William B. (Wayne State Univ., Detroit). Phys. Rev., D; 6: No. 8, 2300-1(15 Oct 1972).

Causal cycle experiments are shown to be valid indictments of any tachyon theory which allows all parts of the cycle to occur. This is to be contrasted with claims to the contrary made in a recent paper by Parmentola and Yee. A means of uniquely determining the Lorentz-invariant causal direction of a beam is described. (auth)

1281 ANALYTIC DECOMPOSITION OF VERTICES WITH ARBITRARY SPIN. Carroll, Raymond (Univ. of Michigan, Ann Arbor). Phys. Rev., D; 6: No. 8, 2113-18(15 Oct 1972).

Williams and Yao introduced a general method for decomposing vertex functions written as totally symmetric tensors. These particular vertex functions represent two on-shell particles of arbitrary spin with integer-spin difference coupling to bosons. The case of half-integer-spin difference is treated by letting the totally symmetric vertex function carry a free Dirac index. All independent covariants consistent with Lorentz transformation properties of the vertex current are written and the constraint equations implicit in the Dirac algebra are developed. This leads to an explicit decomposition into the proper number of independent vertex covariants. As Williams and Yao have shown, the decomposition is free from kinematic singularities. Although the method and results are general, the solutions that correspond to spin ½, 3/2, and 5/2 are explicitly presented. (auth)

1282 CURRENT COMMUTATORS NEAR THE LIGHT CONE. Ezawa, Z. F. (Tokyo Univ.). Phys. Lett.; 41B: No. 5, 605-8 (30 Oct 1972).

Two-current matrix elements are studied in a simple triplet model. Current commutators near the light cone are proposed in terms of fundamental triplet fields. The commutators are shown to yield fixed poles and scaling. It is also shown that spin-0 fields produce q-number Schwinger terms. (auth)

1283 HIGH ENERGY PHYSICS. XVth International Conference, Kiev, August 26–September 4, 1970. Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972). 744p. $19.75. (CONF-700806).

The conference included 25 papers three of which were abstracted previously in NSA. For abstracts of these papers see abstract numbers 25: 7611, 31015, and 33796. Separate abstracts were prepared for 22 papers. (J.F.P.)

For abstracts of individual papers see: 1240, 1251–1254, 1269–1271, 1284, 1285, 1313, 1319, 1338, 1355, 1390, 1391, 1427–1430, 1451, and 1452.

1284 DYNAMICS OF MANY BODY PROCESSES. Chernavskii, D. S. pp 415-36 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

Multiperipheral and statistical theory and quasiclassical models for the dynamics of many-body particle processes are discussed. (J.F.P.)

1285 CURRENT ALGEBRA. Zumino, B. (CERN, Geneva). pp 496-512 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

Developments in current algebra since the Vienna conference are reviewed. The conventional vector and axial vector currents of the electromagnetic and weak interactions and the energy momentum tensor and the currents of scale and conformal transformations are treated. Ward identities and effective Lagrangians, the algebraic form of sum rules, unitarity, outstanding questions, anomalies, a mathematical puzzle, the energy–momentum tensor, scale invariance as a goldstone symmetry, and scale invariance at small distances are covered. (J.F.P.)

Electromagnetic

Refer also to abstracts 1236, 1423, and 1913.

1286 (BNL-17227) ELECTROMAGNETIC AND WEAK INTERACTIONS WITH $\bar{p}p$. Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). 25 Aug 1972. 8p. Dep. NTIS.

The feasibility of observing lepton pair production in electromagnetic and weak p + p and $\bar{p}$ + p interactions using the Intersecting Storage Ring is considered. The rates for these interactions are estimated. (J.F.P.)

1287 SELF-CONSISTENT ELECTROMAGNETIC DUAL AMPLITUDES AND THE ELECTRON–POSITRON SYSTEM. McEnnan, James (Univ. of Florida, Gainesville). Lect. Theor. Phys.; 14A: 275-95(1972).

The construction and properties of self-consistent dispersion-theoretic electromagnetic scattering amplitudes are discussed. The procedure is illustrated for the elastic scattering of spinless particles which only interact electromagnetically. The result is then given for electron-positron scattering. It is pointed out that the electron-positron scattering amplitude appears to exhibit a symmetry which is as close to the usual form of duality as may be possible outside the field of hadron physics. (L.B.S.)

1288 ELECTRON POSITRON ANNIHILATIONS. Cabibbo, N. (Univ., Rome). pp 2-20 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Electron-positron annihilations are discussed under the following headings: the single photon channel; new particles and the photon propagator; weak interactions; annihilation into hadrons; and hadron processes at higher energies. (L.B.S.)

1289 FINITE THEORY OF QUANTUM ELECTRODYNAMICS. Lee, T. D. (Columbia Univ., New York). pp 62-93 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Some recent work on the construction of a finite theory of quantum electrodynamics is discussed, which is based on a general class of field theories in which the S-matrix is fully unitary, but the Lagrangian is not Hermitian. The modified photon field and the modified fermion field are treated. Details of the Feynman diagrams are discussed. Some experimental consequences of the theory are presented. (L.B.S.)

1290 ELECTROMAGNETIC PRODUCTION OF HADRONIC RESONANCES. Salvini, G. (Istituto di Fisica, Rome). pp 320-95 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Lectures are presented on the most significant experiments which established the present knowledge of the theory of quantum electrodynamics and its connection with the hadronic fields. The first section deals with the present state of quantum electrodynamics and experimental limits of present day accelerators. Photons, vectons, hadrons, and vector dominance are treated in the second section. The third section covers vector dominance and photoproduction. (L.B.S.)

1291 POLARIZATION PHENOMENA IN DEUTERON PHOTODISINTEGRATION. Tartakovskii, V. K.; Gurin, Yu. L. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 7, 1125-8(Jul 1972). (In Russian).

The differential cross section and polarization of the photonucleons arising from the deuteron photodisintegration are calculated in case of the arbitrary polarized photons and deuterons. (auth)

1292 LIMITING FRAGMENTATION AND THE HIGH ENERGY COSMIC RAY CASCADE IN THE ATMOSPHERE. Yekutieli, G. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; B47: No. 2, 621-32(1972).

The hypothesis of limiting fragmentation is used to describe the development of C. R. cascade in the atmosphere. It is shown that at high energies (E > 150 GeV), for a primary C. R. spectrum that can be approximated by power law $\sim E^{-\gamma}$, the intensities of C. R. protons, neutrons, pions and muons (in the atmosphere) can be described in terms of six fractional energy moments, $\langle f_{pp}^{\gamma-1}\rangle$, $\langle f_{pn}^{\gamma-1}\rangle$, $\langle f_{p\pi^0}^{\gamma-1}\rangle$, $\langle f_{p\pi^-}^{\gamma-1}\rangle$, $\langle f_{\pi^+\pi^0}^{\gamma-1}\rangle$, and $\langle f_{\pi^+\pi^-}^{\gamma-1}\rangle$, of single nucleons and pions emitted in the fragmentation of nucleons and pions. With appropriate choice of fractional energy moments, the model was able to yield: an attenuation mean free path, in the atmosphere, of nucleons plus pions of about 130 g/cm^2, a μ^+/μ^- = 1.25 ratio and a differential μ meson spectrum at sea level in agreement with cosmic rays observations. This model with fractional energy moments obtained from accelerator experiments yield similar C. R. results however, with somewhat higher μ^+/μ^- ratio of 1.55. (auth)

1293 FAMILY OF SUM RULES FOR WEAK, ELECTROMAGNETIC AND STRONG PROCESSES. Lukaszuk, L. (Inst. of Nuclear Research, Warsaw). Nucl. Phys.; B47: No. 2, 569-88(1972).

New sum rules are derived for the neutrino-electron and pion-pion Compton forward scattering amplitudes, and for the pion's electromagnetic form factor. It is also shown that a peak in the differential cross section or form factor has to be connected with the positive derivative of the phase at the maximum, provided that the peak is steep enough and/or dominating over a sufficiently large region. (auth)

1294 DIAGRAMMATIC METHOD FOR CALCULATING TIME RESOLVED DECAY CURVES. Hyman, Ellis. Philadelphia; Univ. of Pennsylvania (1972). 153p. University Microfilms Order No. 72-25,592.

Thesis.

A new diagrammatic application of perturbation theory is presented. The method is suited particularly to the analysis of a many-body system into which is inserted a particle which both scatters with the many-body system and undergoes annihilation in the medium. It is used, specifically, to calculate the time resolved decay rate of a nonrelativistic positron inserted in an electron gas. In formulating the problem it is shown that, unlike the case in the usual decay problem, the single particle positron Green's function does not contain sufficient information to determine the positron decay. The required function is obtained by appropriate analytic continuation of a product of 2 single particle positron Green's functions and a vertex function. It is shown how a model can be defined that satisfies two necessary physical requirements: in the limit of no decay interaction the positron number must be 1 for all time, and for nonzero decay interaction, no matter how small, the positron number must approach zero for sufficiently large times. To meet the first requirement, the vertex function in the zero decay theory must satisfy a generalized Ward's identity. To satisfy the second requirement the positron Green's function in the zero decay theory must exhibit a real pole. Classes of Feynman diagrams are exhibited which satisfy these requirements. Finally, it is shown how the required product function must be analytically continued around a branch cut into the lower half of the complex plane, an operation which is seen to be nontrivial in this decay problem. For very small decay interaction an exact solution to the positron-electron gas problem is obtained. The decay is shown to be exponential. For the more general case, where the decay interaction is comparable to the Coulomb interaction, an explicit solution was not obtained. However, the required classes of Feynman diagrams are exhibited and a prescription for obtaining a physically meaningful solution is outlined. The solution will no longer be limited to a simple exponential decay. (Diss. Abstr. Int., B)

1295 RELATIVISTIC COULOMB SCATTERING. Rosen, Bernard. New York, N. Y.; New York Univ. (1959). 62p. University Microfilms Order No. 72-24,531.

Thesis.

Contour integration is employed to evaluate analytically the correction terms to the Rutherford cross section for high energies. The sum of partial waves is replaced by an equivalent integral which is expanded in powers of the fine structure constant. Evaluation of the resultant integrals is performed wherever possible by use of integral representations for the transcendental functions appearing in the integrands; an unsuccessful attempt to determine the values of the integrals by the saddle point approximation is briefly sketched. Those terms which appear in the cross section to the fifth order in the fine structure constant are explicitly given by closed analytic expressions. The general form of the correction term corresponding to an arbitrary power of the fine structure constant is found in terms of two dimensional integrals involving elementary transcendental functions. A related problem, the nonrelativistic scattering for an attractive $1/r^2$ potential, is also discussed. (Diss. Abstr. Int., B)

1296 APPROXIMATIONS TO ATOMIC FIELD PAIR PRODUCTION AND BREMSSTRAHLUNG FOR A POINT COULOMB POTENTIAL. Fink, Joanne Krupey. Pittsburgh; Univ. of Pittsburgh (1972). 201p. University Microfilms Order No. 72-22,941.

Thesis.

An analytic expression for an approximation to the differential pair production cross section is obtained using Furry–Sommerfeld–Maue wave functions for the electric and positron. It is shown that this expression reduces to the Bethe–Maximon approximation and the Born approximation in the appropriate limits. Numerical results for the cross section differential in positron angle and energy and for the cross section differential in positron energy are obtained so that comparison is made with results of the Born approximation, and with the Bethe–Maximon approximation for a range of z and photon energies and with "exact" numerical calculations at low photon energies. It is found that the cross sections of the Born approximation and the Bethe–Maximon approximation may be related to the cross section of the present approximation by a normalization theory similar to the one used to relate unscreened and screened "exact" calculations for pair production. There exists a small region—that of small z and low photon energy—where the present theory is significantly better

than the Born approximation or the Bethe–Maximon approximation. Comparisons are made with total cross section experiments in this region. From comparison with "exact" numerical calculations at low energies, it is found that none of the approximations considered gives good results for high z at low photon energies. Further αz corrections to the present theory have been found to give improvement at intermediate z but still fail for high z. For intermediate and high z at low energies, the present approximation differs from "exact" numerical calculations in the shape of the angular distribution as well as in magnitude. This difference is due to large differences in the shape of the wave functions for low energies in the region of configuration space which is important for the pair production processes as well as to differences in normalizations at the origin. A similar analysis for the corresponding approximation to the bremsstrahlung cross section is made. (Diss. Abstr. Int., B)

1297 MULTIPLE-TIME-SCALE ANALYSIS ON THE THEORY OF FLUCTUATION AND THE SPONTANEOUS COHERENT RADIATION. Lee, Paul Shu-jone. Buffalo; State Univ. of New York (1972). 105p. University Microfilms Order No. 72-27,261.

Thesis.

From the Liouville equation, by the method of multi-time scales, a generalized Boltzmann equation with fluctuation is obtained on statistical considerations of the randomness of the many-particle correlations in the macroscopic picture. These fluctuations lead to an H theorem in which the H function decreases, with fluctuations, with time toward equilibrium. These fluctuations furnish a source for a random force term introduced by Fox and Uhlenbeck in the Boltzmann equation. The multiple-time-scale perturbation theory is used to investigate the coherent enhancement of the spontaneous radiation. This method has the advantage that it can be easily generalized to a system of arbitrary number of particles and provides a justification of the assumption made in Wigner–Weisskopf method. A system of one, two and three particles is studied and generalized to an N-body system. The result shows that there is a many body effect on the coherent broadening of radiation linewidth, even when the interparticle distance is not small as compared with the spontaneous radiation wavelength. (Diss. Abstr. Int., B)

1298 ASYMPTOTIC EXPANSIONS OF FOURIER INTEGRALS WITH LIGHT CONE SINGULARITIES. Schwarz, Fritz (Univ., Kaiserslautern, Ger.). J. Math. Phys.; 13: No. 10, 1621-34 (Oct 1972).

Let the integral transforms $\tilde{\phi}(y)$ and $\tilde{\phi}(y_1,y_2)$ be defined through $\tilde{\phi}(y) = \int d^4x e^{ixy} s(x)\phi(x)$ and $\tilde{\phi}(y_1,y_2) = \int d^4x_1 e^{ix_1y_1} \int d^4x_2 e^{ix_2y_2} s(x_1,x_2)\phi(x_1x_2)$, respectively. All variables x and y are 4-vectors in Minkowski space. The functions ϕ are elements of S, and the factors s contain certain types of light cone singularities. The integral transforms $\tilde{\phi}$ are investigated with respect to their characteristic properties implied by these light cone singularities using the method of van der Corput's neutralizers. It turns out that the behavior of $\tilde{\phi}$ is determined by the light cone singularities if one goes to infinity in the space of the y variables along an arbitrary straight line. All characteristically different cases are classified and for each case a complete asymptotic expansion is derived. (auth)

1299 ALGEBRAIC SOLUTION FOR A DIRAC ELECTRON IN A PLANE-WAVE ELECTROMAGNETIC FIELD. Beers, Brian; Nickle, H. H. (Southern Illinois Univ., Carbondale). J. Math. Phys.; 13: No. 10, 1592-5(Oct 1972).

An algebraic classification is given for the solutions of the Dirac equation for an electron interacting with a classical plane-wave electromagnetic field. The solutions appear as the carrier space of the direct sum of the positive and negative energy, mass m, spin-½ representations of the restricted Poincaré group. An explicit construction is given for the generators of the representation. The explicit position space form of the solutions follows readily from the relatively simple form of these operators. Via these solutions, an expression for the propagator of the interacting electron is given. (auth)

1300 $\eta \rightarrow 3\pi$ DECAYS AND OCTET SCALAR MESONS. Takahashi, Junji (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 540-5(Aug 1972).

The $\eta \rightarrow 3\pi$ decays are calculated in a meson-pole-dominance model, assuming the existence of an octet of scalar mesons. An SU(3)-symmetric interaction of a scalar meson and two pseudoscalar mesons is considered. By virtue of this interaction, the η-π^0 transition estimated from the ordinary SU(3) argument reproduces the decay rate $\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0) = 0.58$ keV, which is in very good agreement with the experimental value. The coupling constant between the scalar and pseudo-scalar mesons, evaluated from the Dalitz-plot slope of the $\eta \rightarrow \pi^+\pi^-\pi^0$ decay, is found consistent with the present experimental data on the decay widths of scalar mesons. (auth)

1301 NEAR UNIVERSALITY OF THE STRUCTURE FUNCTIONS AND THE FORM FACTORS IN THE DUAL RESONANCE MODEL. Niegawa, Akira (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 513-39(Aug 1972).

Continuing previous studies, the analytic properties of the virtual Compton-scattering amplitude and the form factor of a target-meson of any spin obtained from the dual resonance model of Kikkawa and Sato are investigated. The relevant quantities are examined in detail under the planar one-loop approximation. The main conclusions are as follows: the amplitudes satisfy the Fubini–Dashen–Gell-Mann sum rule, Bjorken's scaling law (in the case of the function F_2 only), and only the unrenormalized amplitude has the correct Regge behavior. In particular, it is shown that the scaling functions $F_2(\omega)$ have the remarkable property of "near universality", i.e., its behavior in the threshold- and asymptotic-regions is nearly independent of the spin of the target mesons. It is shown that the renormalized amplitudes have properties similar to those mentioned above except that it has wrong Regge behavior. This latter fact means that the straightforward application of the renormalization method of the Princeton group to this model is not suitable. The asymptotic-behavior of the form factors and their connection to the threshold behavior of $F_2(\omega)$ are also studied in some detail. Finally the physical implications of the results are discussed in relation to those of several authors. (auth)

1302 DEEP INELASTIC CONTRIBUTION TO ELECTROMAGNETIC MASS DIFFERENCE. Okumura, Yoshitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 490-8(Aug 1972).

It is investigated how one may deal with the logarithmic divergence of the electromagnetic mass difference due to the scale invariance in the deep inelastic region. It will be shown that the divergence can be replaced by the effective quark mass in a hadron by the renormalization technique similar to that in quantum electrodynamics. An alteration of the Coleman and Glashow relation is investigated. (auth)

1303 RIGOROUS RELATION FOR STRUCTURE FUNCTIONS. Patil, S. H. (Indian Inst. of Tech., Bombay). Phys. Rev., D; 6: No. 8, 2198-2202(15 Oct 1972).

A theorem in field theory, due to Lehmann, Symanzik, and Zimmermann, implies that a certain combination of proper structure functions for $e\bar{e}$ annihilation scales trivially. This result is valid for experimental structure functions if the charge renormalization constant Z_3^{-1} is finite. If W_1 and νW_2 scale separately, it is found that their scale functions satisfy the relation $F_1(\omega) = \frac{1}{3}\omega F_2(\omega)$. The constraints imposed by the theorem are exemplified by a soluble model. (auth)

1304 UNIFIED LIGHT-CONE TREATMENT OF SCALING AND A POSITIVITY CONSTRAINT ON SHORT-DISTANCE BEHAVIOR. Bitar, Khalil M. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 6: No. 8, 2250-61(15 Oct 1972).

It is shown that scaling in the two processes $e + \Pi(p) \rightarrow e + X$ and $e^+ + e^- \rightarrow \Pi(p) + X$ (where Π denotes a hadron) is controlled by the behavior near the light cone of the same operator product. This is done by studying the structure of the absorptive part of the forward virtual Compton scattering amplitude. This operator product must exhibit (at least) the singularity structure of the product of two electromagnetic currents. Under the assumption that this indeed is its leading singularity, it is concluded that both processes must exhibit the same scaling behavior. It is then shown that positivity leads to a restriction on the short-distance behavior of these products. Under fairly general assumptions this leads to the result that the longitudinal structure function in the process $e^+ + e^- \rightarrow \Pi(p) + X$ may not vanish identically. The alternatives are that either local operators contribute on the light cone or that the transverse functions satisfy the lower bound $F_T \geq c\omega$ as ω approaches infinity. (auth)

1305 TESTS OF LIGHT-CONE COMMUTATORS. II. Dicus, Duane A. (Univ. of Rochester, N. Y.); Teplitz, Vigdor L. Phys. Rev., D; 6: No. 8, 2262-74(15 Oct 1972).

Light-cone commutators are used to derive fixed-mass sum rules for structure functions evaluated away from the forward direction. Both spin-averaged and spin-dependent sum rules are considered. As in the forward direction these sum rules relate the structure functions to form factors of bilocal operators. The bilocal operators can, in turn, be related to the deep-inelastic limits of the structure functions by Fourier transformations. These relations are derived for the spin-averaged case. In addition the Mandelstam representation is used to show the consistency of the scaling hypothesis was crossed-channel unitarity. (auth)

1306 COMMENT ON A NEW EQUATION OF MOTION FOR CLASSICAL CHARGED PARTICLES. Leiter, Darryl (Univ. of Windsor, Ont.); Mo, Tse Chin; Papas, C. H. Phys. Rev., D; 6: No. 8, 2292-4(15 Oct 1972).

A criticism is offered on the point of view, taken recently by Mo and Papas, that their new equation of motion for charged particles should replace the Lorentz–Dirac equation in the classical description of charged-particle motion. A reply is given to this criticism. (auth)

1307 PAIR PRODUCTION IN A VACUUM BY AN ALTERNATING FIELD. Troup, G. J.; Perlman, H. S. (Monash Univ., Clayton, Australia). Phys. Rev., D; 6: No. 8, 2299(15 Oct 1972).

The application by Brezin and Itzykson of their calculation of pair production in an alternating electric field to a focused laser beam is discussed. A focused laser beam will be much closer to a null (E = B), wrenchless ($\vec{E} \cdot \vec{B} = 0$) electromagnetic field than to an alternating electric field. Failure to take account of the associated magnetic field could invalidate the application. (auth)

1308 VECTOR MESON DOMINANCE APPROACH TO SCALE INVARIANCE. Bramon, A.; Etim, E.; Greco, M. (CNEN, Frascati, Italy). Phys. Lett.; 41B: No. 5, 609-12(30 Oct 1972).

A model of scale invariance for both deep inelastic scattering and e^+e^- annihilation incorporating an infinite number of vector mesons is proposed. Structure functions are calculated explicitly in good agreement with experiments. Precocious scaling arises naturally in the model. (auth)

1309 SCREENING AND SECOND BORN CORRECTIONS TO BREMSSTRAHLUNG AT INTERMEDIATE ENERGIES. Borie, E. (Univ., Frankfurt am Main). Nuovo Cim.; 11A: No. 4, 969-82(21 Oct 1972).

The effect of screening on bremsstrahlung cross sections at medium energy is studied. A formula is derived which reduces the integration of the Bethe-Heitler formula over electron angles to a single integration, which is done numerically, without approximations as to energy or angle, for arbitrary form factors. Although the calculation is confined to Born approximation, it provides a computationally simple method for calculating the effects of screening in energy regions for which such calculations have not previously been possible. A similar method is used to compute bremsstrahlung cross sections in second Born approximation. Cross sections differential in photon energy and angle, as well as total cross sections are presented for the cases Z = 13, 79, using the Molière form factor to describe the screening, and a comparison is made with other recent calculations. (auth)

1310 CURRENT ALGEBRAIC SUM RULES AND VENEZIANO MODEL FOR PHOTOPRODUCTION OF PIONS OFF NUCLEONS. Roychowdhury, A.; Banerjee, S. N. (Jadaupur Univ., Calcutta). Nuovo Cim.; 11A: No. 4, 931-6(21 Oct 1972).

Sum rules relating the proton and the neutron magnetic moments to amplitudes for $\gamma + \mathcal{N} \to \pi + \mathcal{N}$ are analyzed in the framework of the dual-resonance model, and reasonably good agreement is obtained. (auth)

1311 ELECTRON FORM FACTORS UP TO FOURTH ORDER. I. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Mignaco, J. A.; Remiddi, E. Nuovo Cim.; 11A: No. 4, 824-64 (21 Oct 1972).

The explicit results of the analytic evaluation of the discontinuities of the electron form factors and of their zero–momentum-transfer values, up to the fourth order of the perturbative expansion of QED in the electric charge, are presented. Asymptotic and threshold behaviors are discussed. The related form of the dispersion relations for the real parts is given. (auth)

1312 ELECTRON FORM FACTORS UP TO FOURTH ORDER. II. Barbieri, R. (Scuola Normale Superiore, Pisa, Italy); Mignaco, J. A.; Remiddi, E. Nuovo Cim.; 11A: No. 4, 865-916(21 Oct 1972).

The methods and the techniques developed and used in foregoing work for the evaluation of the radiative corrections to the electron form factors up to fourth order in the electric charge (two internal loops) in QED are presented. (auth)

1313 ELECTROMAGNETIC INTERACTIONS. Soloviev, L. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 513-43 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The review of electromagnetic interactions covers quantum electrodynamics in higher orders at low and high energies and in models, deep inelastic scattering of electrons on nucleons, pion and nucleon elastic form factors, and Compton scattering on protons. (J.F.P.

Weak

Refer also to abstract 1243.

1314 REMARKS ON THE $|\Delta I| = \frac{1}{2}$ RULE IN NONLEPTONIC WEAK DECAYS. Lee, T. D. (Columbia Univ., New York). pp 288-305 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

It was previously suggested that by investigating the behavior of transition amplitudes in the soft-pion limit, an approximate $|\Delta I| = \frac{1}{2}$ rule can be derived for the physical nonleptonic kaon decays, even though the weak interaction Lagrangian contains $|\Delta I| \geq \frac{1}{2}$ components. These soft-pion limits are first reviewed, and the incorrectness of this conclusion is demonstrated. It is shown that the soft pion limits do not imply the $|\Delta I| = \frac{1}{2}$ rule for the physical nonleptonic kaon decays. Some speculations are given on the origin for the observed $|\Delta I| = \frac{1}{2}$ rule. (L.B.S.)

1315 PION-POLE DOMINANCE OF THE DIVERGENCE OF THE WEAK PARITY-NONCONSERVING NNρ AMPLITUDE. McKellar, Bruce H. J. (Michigan State Univ., East Lansing); Pick, Peter. Phys. Rev., D; 6: No. 8, 2184-8(15 Oct 1972).

Using the hypothesis of pion-pole dominance of the divergence of the weak parity-nonconserving NNρ amplitude the axial-vector form factor for the amplitude is expressed in terms of the amplitude for the parity-nonconserving transition $\rho \to \pi$. This result enables one of the unknown parameters in the previous calculation of the NNρ amplitude to be fixed using the $SU(6)_w$ symmetry properties of the Hamiltonian. Reasonable assumptions for the other parameter suggest that the NNρ amplitude is about 6 times larger than the factorization value. (auth)

1316 RENORMALIZATION OF A WEAK-INTERACTION MODEL. Delbourgo, R. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 11A: No. 4, 943-68(21 Oct 1972).

The prototype weak-interaction coupling $\frac{1}{2}g\bar{\psi}W \cdot \gamma(1 - i\gamma_5)\psi$ of a boson W (mass μ) to a spinor field (mass m), gauge-transformed to a nonpolynomial form, is considered, and the detailed renormalization program for it is set up. The effective cut-off for the longitudinal W interactions is provided by the "Fermi constant" $G = g^2/\mu^2$ and the remaining (renormalizable) "infinities" due to the transverse W interactions can be rendered finite by invoking the further gravitational interactions of the fields. The finite radiative corrections are given as an asymptotic series in g and m/μ, assumed small, and the procedure is illustrated by treating spinor-spinor scattering. (auth)

1317 LIGHT-CONE ASPECT OF INELASTIC NEUTRINO SCATTERING. Georgelin, Y.; Sazdjian, H.; Stern, J. (Institut de Physique Nucleare, Orsay, France). Nuovo Cim.; 11A: No. 4, 983-1005(21 Oct 1972).

The hypothesis of universal light-cone behavior of current commutators formulated previously is applied to the deep inelastic neutrino-nucleon scattering. It is shown that it yields the scaling laws of the parton model and, provided the nonleading light-cone singularities are of certain type, it reproduces the current algebra sum rules for the scaling functions. One new sum rule is obtained relating the longitudinal scaling function to the equal-time commutator of the weak-current charge with the weak-current divergence. Particular attention is paid to the light-cone aspect of an eventual vanishing of the longitudinal scaling function $F_S(\xi)$. It is shown that $F_S(\xi) = 0$ both in electron and neutrino inelastic scattering would imply that the currents might satisfy the $U_3 \otimes U_3$ algebra at equal "lightlike times" $x_\perp = (1/\sqrt{2})(x_0 - x_3)$ without operator Schwinger terms, as is suggested by the quark model. (auth)

1318 NONLEPTONIC DECAYS OF HYPERONS IN A CURRENT–CURRENT INTERACTION. Esteve, A.; Gutierrez, J.; Tiemblo, A. (CSIC, Madrid). Nuovo Cim.; 11A: No. 4, 817-23 (21 Oct 1972).

A current–current Lagrangian model for nonleptonic hyperon decays is presented. The tadpole hypothesis is explicitly used in the theory. P-waves are explained by means of a symmetry-breaking interaction. The results are in good agreement with experiments. (auth)

1319 SOME THEORETICAL PROBLEMS OF DEEP INELASTIC LEPTON–HADRON INTERACTIONS. Muradyan, R. M. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 658-66 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review is given of some work on the deep inelastic lepton–hadron processes on the basis of automodelity or scale invariance, current algebra sum rules and current commutators, and vector dominance. (J.F.P.)

Strong (General)

1320 (ORO–3992-109) ANALYTIC SOLUTION OF THE TRUNCATED STATISTICAL BOOTSTRAP EQUATION WITH STEP-FUNCTION KERNEL. Chiu, C. B.; Johnsen, J. (Texas Univ., Austin. Center for Particle Theory). Oct 1972. Contract AT(40-1)-3992. 9p. (CPT–163). Dep. NTIS.

Analytic expressions for the total level density, the pion multiplicity distribution and the average pion energy of the truncated statistical bootstrap equation with a step function kernel are presented. (auth)

1321 NARROW-RESONANCE MODELS COMPATIBLE WITH DUALITY AND THEIR DEVELOPMENTS. Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 94-169 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A series of lectures devoted to resonance particles exhibiting duality is presented, which is limited to the theoretical properties of dual amplitudes for the collision of any number of spinless particles. The derivation and properties of the 4-point function are discussed. The n-point function for scalar particles is then discussed. The group of projective transformations, manifestly dual formulation with operators, and further developments at the tree-approximation level and unitization attempts are discussed. (L.B.S.)

1322 MODELS FOR HADRONIC REACTIONS: DUALITY, ABSORPTION, AND QUARKS. Harari, H. (Weizmann Inst. of Science, Rehovot, Israel). pp 170-227 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

An outline is given of the overall dual picture which supposedly describes hadronic processes with two-body final states. Some of the tests that are relevant to the various components of this picture are briefly mentioned. The material is presented as a collection of relevant figures and figure captions. (L.B.S.)

1323 PROBLEMS IN MESON SPECTROSCOPY. Maglic, B. (Rutgers–The State Univ., New Brunswick, N. J.). pp 396-448 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The problems associated with the new features in meson physics are discussed. These include: fine structure in meson spectrum; empirical regularity in meson spectrum; mesons heavier than two nucleons and direct-channel resonances; and anomalous structure in meson spectrum-splitting of the A_2 meson. In addition, the old problem of low-energy $\pi\pi$ scattering is examined in light of new predictions and new results. The principle of the Precetron and its application to $\pi\pi$ collisions are described. (L.B.S.)

1324 LECTURES IN THEORETICAL PHYSICS. VOLUME XIV A. TOPICS IN STRONG INTERACTIONS. Barut, Asim O.; Brittin, Wesley E. (eds.). Boulder, Colo.; Colorado Associated University Press (1972). 477p. $15.00.

Fourteen lectures are included; a separate abstract was prepared for each lecture. (L.B.S.)

For abstracts of individual lectures see: 1287, 1325–1330, 1403, 1404, 1440–1443, and 1910.

1325 RELATIVISTIC EIKONAL MODEL. Sugar, Robert L. (Univ. of California, Santa Barbara). Lect. Theor. Phys.; 14A: 47-100(1972).

An attempt is made to construct a simple model of ultrahigh energy hadron interactions using the eikonal approximation. The scattering of two high-energy particles which interact via the exchange of elementary quanta is first considered. In order to introduce inelasticity into the model the exchange of compound objects such as $\lambda\phi^3$ ladders and quantum electrodynamic towers are considered. These diagrams lead to models whose predictions are discussed in some detail. Finally the information gained from the study of Feynman graphs is used to construct a simple model of production amplitudes. These amplitudes are used to build a model of the Pomeranchuk singularity. (L.B.S.)

1326 INTRODUCTION TO DUAL RESONANCE MODELS. Bardakci, K. (Univ. of California, Berkeley). Lect. Theor. Phys.; 14A: 157-80(1972).

A brief review is given of dual resonance models. The following topics are discussed: elementary duality and consequences; quark diagrams and planar duality; the Veneziano formula and some applications; many particle amplitudes, and factorization. (L.B.S.)

1327 PRESENT STATUS OF DUAL MODELS. Squires, E. (Univ. of Durham, Eng.). Lect. Theor. Phys.; 14A: 181-239 (1972).

The concept of duality is discussed in view of how far the various ingredients of duality are experimentally supported. Dual models are then briefly described; in particular, some of the difficulties of extending dual models to realistic particles are discussed. Predictions of the dual model are then compared with experiment. An attempt is made to see how far the constraints inherent in dual models are supported by the data. Finally, some particular topics in the application of duality ideas to inclusive reactions are treated. (L.B.S.)

1328 GROUP THEORETICAL PROPERTIES OF DUAL RESONANCE MODELS. Ramond, P. (National Accelerator Lab., Batavia, Ill.). Lect. Theor. Phys.; 14A: 241-74(1972).

An attempt is made to show the emergence of a very fundamental group theoretical structure that seems to underlie all dual resonance models built to date. The role of SU(1,1) in dual resonance models is studied in some detail. Following mathematical preliminaries, the group theoretical rules for the construction of dual factorizable tree amplitudes are treated. The derivation of the N-point Veneziano function is then given in detail. Gauge conditions, dual vertices for excited states, and dual models with additional quantum numbers are then discussed. (L.B.S.)

1329 POSSIBLE PHYSICAL BASIS FOR SOME MATHEMATICAL MODELS OF STRONG INTERACTIONS: ATOMS WITH MAGNETIC CHARGES. Barut, A. O. (Univ. of Colorado, Boulder). Lect. Theor. Phys.; 14A: 339-47(1972).

It is conjectured that a definite physical picture leading to explicit models of hadrons, analogous to models of atoms and nuclei, exist, where the interaction is known precisely. The model incorporates the following: magnetically neutral bound states made up of positive and negative magnetic charges. Consequences of the model are discussed. Some examples are given of implications of the model for hadron scattering processes. (L.B.S.)

1330 FLUX QUANTIZATION AND PARTICLE PHYSICS. Jehle, H. (George Washington Univ., Washington, D. C.). Lect. Theor. Phys.; 14A: 399-419(1972).

A consistent theory of leptons based on quantized flux loop is discussed. Closed magnetic flux loops are assumed to have the forms of magnetic field lines of a dipole source if an electron or muon is considered. It is proposed that a neutrino be also a flux loop. Mesons and baryons are discussed within the scheme of the SU(6) quark picture. A quark is assumed to be a flux loop if it is interlinked with another loop (in the case of a meson) or with two other loops (in the case of a baryon). The structure of quark loops is discussed in detail. (L.B.S.)

1331 EXPERIMENTAL CONSEQUENCES OF POSITIVITY AND DUALITY IN THE ZERO-WIDTH APPROXIMATION. Coon, D. D. (Univ. of Pittsburgh); Geffen D. A. Contracts AT(11-1)-1764; AT(30-1)-3829. AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 381-90(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

A rigorous, model-independent treatment of positivity and duality is reviewed and experimental implications are discussed. Under the assumption that dibaryon resonances do not exist or do not participate in duality, it is shown that the least massive spin J meson which couples to baryons must have I = 0 and P = C = $(-1)^J$ for all $J \geq \alpha(0)$, the leading effective trajectory intercept. When degeneracy occurs, the couplings of the I = 0, P = C $(-1)^J$ mesons must dominate. The mass inequalities $M_\omega \leq M_\rho$, $M_\omega \leq M_K$, $M_f \leq M_{A2}$, $M_f \leq M_{K^*}$, follow immediately. Among the implications for $J > 2$ is some rather strong support for a $J^P = 3^-$ assignment for the $\phi(1675)$ as well as a $K\bar{K}$ decay mode for this resonance. Inequalities involving meson and baryon masses are also obtained. Inequalities are found among couplings of arbitrary spin baryons to recurrences on the leading meson trajectory. Stronger inequalities follow from the additional assumptions of nonet ω–ϕ mixing with SU_3 invariant couplings to the baryon octet and decoupling of ϕ from the proton. The agreement between presently available experimental data, previous models for couplings, and results obtained for $B\bar{B}$ systems from positivity, duality, and the assumption of no dual dibaryon resonances, tends to indicate that duality does apply to $B\bar{B}$ systems. This in turn provides some general support for the existence of exotic mesons which couple to baryons. (L.B.S.)

1332 GHOST-FREE DUAL MODEL WITH LEADING INTERCEPT MINUS ONE. Gervais, J. L.; Neveu, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B47: No. 2, 422-35(1972).

A dual model where the leading intercept is −1, and where there are enough gauge conditions to remove all the ghosts when the dimension is less than or equal to the critical value 26 is constructed. The model factorizes with the usual harmonic oscillator operators of the conventional model. (auth)

1333 UNITARIZATION AND THE ABSORPTION REGGE CUT IN THE DUAL MODEL. Yamagishi, Kenji (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 2, 553-65(Aug 1972).

A new unitarization approach in the two-component dual model is proposed. It is shown that the absorption Regge cut exists if there are amplitudes which satisfy two-component duality. (auth)

1334 PARTIAL DIFFERENTIAL EQUATIONS WITH RESPECT TO COUPLING CONSTANTS: ELECTROMAGNETIC MASS DIFFERENCE OF HADRONS. Soln, Josip (Univ. of Illnois, Chicago). Phys. Rev., D; 6: No. 8, 2277-91(15 Oct 1972).

The partial differential equations with respect to strong and electromagnetic coupling constants are established for the S matrix, Heisenberg operators, and "out" field operators. The macrocausality relations—vanishing of derivatives with respect to coupling constants for free "in" field operators—are important in the formalism. As a consequence of macrocausality relations, observable masses do not depend on strong and electromagnetic coupling constants. This makes the observable n−p mass difference uncomputable. Thus, our approach goes along the lines of divergent (but renormalizable) field theory. The existence of non-electromagnetic interactions which make $m_n - m_p \neq 0$ when $e = 0$ is assumed. The partial differential equations with respect to strong and electromagnetic coupling constants are derived for bare n and p masses. In order to integrate these differential equations, the observable n and p must be known a priori. After integrating these differential equations, a formal expression for the observable n−p mass difference is obtained. This expression, compared with the usual expression from the literature, besides containing the difference of n and p mass shifts due to the electromagnetic interactions ("renormalized" by strong interactions), also contains the bare n−p mass difference and the difference of n and p mass shifts due to strong interactions. The usual expression for the n−p mass difference cannot be recovered since this expression, as far as the observable n−p mass difference is concerned, is an identity and not the relation from which it can be computed. (auth)

1335 HADRONIC EIKONAL MODEL. Chang, L. N.; Segre, G. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 6: No. 8, 2231-43(15 Oct 1972).

A model for hadron−hadron scattering proceeding via the exchange of mesonic systems with isospin is constructed. The result can be cast in eikonal form with an effective Regge-pole potential. Extensions of the model are discussed and comparisons with other models are made. (auth)

1336 UNITARY MULTIPERIPHERAL MODELS. Auerbach, S. (Univ. of California, Santa Barbara); Aviv, R.; Sugar, R.; Blankenbecler, R. Phys. Rev., D; 6: No. 8, 2216-31(15 Oct 1972).

The method of constructing unitary S matrices developed in a recent paper is generalized and applied to two versions of the multiperipheral model. In these models the standard perturbation expansion of the S matrix diverges, so an alternative expansion with improved convergence properties is developed. It is shown that the unitarity condition generates a new type of cut in the angular momentum plane which is dynamical in origin in contrast to the essentially kinematical Mandelstam cuts. This new type of cut ensures that the Froissart bound on the total cross section is obeyed. In an exactly solvable model it is shown that the contribution of the multi-Regge region of phase space to the total cross section always decreases as a power of the energy if the input Regge trajectory is unity or less. It is argued that the qualitative features of the models discussed here will hold for a wide class of multiperipheral-like models. (auth)

1337 TOTAL CROSS SECTIONS AND DIFFRACTION CONE SLOPE. Sukhorukov, S. T.; Ter-Martirosyan, K. A. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 41B: No. 5, 618-20(30 Oct 1972).

A comparison is made of the theoretical predictions obtained using a unique set of Regge parameters with the new Serpukhov and CERN data on the values of σ_{tot} for $K^{\pm}N$, $\pi^{\pm}P$, NN, and $\bar{N}N$ and on the slopes $b_0 = b_0(E)$ of the pp scattering cone. (L.B.S.)

1338 DYNAMICS OF THE TWO-BODY AND QUASI-TWO-BODY PROCESSES AT HIGH ENERGIES. Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 367-414 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review of theoretical investigations on two-body and quasi-two-body processes at high energies with an attempt to unify the material according to some principles from quantum field theory is presented. The experimental data, Regge phenomenology, the quasi-optical approach, the unitarity condition at high energies, analysis of the Serpukhov data and new models for asymptotic behavior, and the theory of strong interactions at high energies are covered. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstracts 1258 and 1401.

1339 (BNL-17218) EMPIRICAL FORMULA FOR PION PRODUCTION IN PROTON PROTON COLLISION UP TO 1500 GeV. Wang, C. L. (Brookhaven National Lab., Upton, N. Y.). 6 Sep 1972. 32p. Dep. NTIS.

A semiempirical formula which well represents the double differential cross section for pion production in high energy pp collisions is presented. The formula agrees with all data between 20 and 1500 GeV to within a factor of ~2 and is consistent with scaling and limiting fragmentation. Also presented is a set of momentum spectra at some interesting energies. (auth)

1340 EXPERIMENTAL MESON SPECTROSCOPY, 1972. Third International Conference on Experimental Meson Spectroscopy, Philadelphia, Pennsylvania, April 28–29, 1972. Rosenfeld, Arthur H.; Lai, Kwan-wu (eds.). AIP Conference Proceedings, Number 8. New York; American Institute of Physics (1972). 501p. (CONF-720409).

Thirty-two papers are included; individual abstracts are prepared for nineteen. Thirteen papers were previously abstracted for NSA and appeared as CONF-720409-2-14. (L.B.S.)

For abstracts of individual papers see: 372, 1233, 1246, 1247, 1258–1263, 1331, 1341, 1346, 1359, and 1360.

1341 COMMENTS ON THE $\pi\pi$ SESSION. Selove, W. (Univ. of Pennsylvania, Philadelphia). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 1-3(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

Recent experiments have removed the long standing ambiguities in the s-wave $I = 0$ $\pi\pi$ phase shift, δ_0^0. There is good evidence for a very sharp threshold-resonance effect near 980 MeV, and for a broad near-90° effect in the 700 MeV region. (auth)

1342 DILEMMA WITH THE UNIQUE SET OF δ_0^0 OF PROTOPOPESCU ET AL. Gutay, L. J. (Purdue Univ., Lafayette, Ind.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 59-64(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

An apparent contradiction between a unique set of δ^0, and the isotropic term of the $\pi\pi$ angular distribution is discussed. (auth)

1343 EXTRAPOLATIONS TO THE PION POLE. Williams, P. K. (Florida State Univ., Tallahassee). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 65-75(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA (28 Apr 1972). See CONF-720409.

Absorption models are used as guides to the methodology of cross-section and moment extrapolations to the pion pole for the purposes of obtaining detailed information on $\pi\pi$ and $K\pi$ phase shifts. Model moments for the reaction $\pi^+ + p \rightarrow \pi^+ + \pi^- + \Delta^{++}$ are presented. (auth)

1344 EFFECTS FROM LINEAR DYNAMICAL ZEROS IN OFF-SHELL $\pi\pi$ AND $K\pi$ SCATTERINGS. Odorico, R. (Argonne National Lab., Ill.). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 77-90(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

Effects in $\pi\pi$ and $K\pi$ systems similar to that recently observed in $\pi^+\pi^-$ at 980 MeV are shown to find a natural interpretation in terms of approximately linear propagation of zeros in the meson-meson scattering amplitude. Linearity of amplitude zeros is sup-

ported by experimental evidence in meson-baryon two-body processes at low-energy, some examples of which are discussed. (auth)

1345 COMMENTS ON MESON STATES WITH $M > 2M_N$. Cline, D. B. (Univ. of Wisconsin, Madison). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 205-7(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

A comment is made indicating the positive evidence for the existence of meson states with mass greater than $2M_N$ in light of the present controversy over the original data presented by the CERN missing mass spectrometer group. An error in the original CERN cross section measurements is reported. (auth)

1346 ENERGY DEPENDENCE OF S, T, U RESONANCES. Kienzle, W. AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 207-8(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The energy dependence of S, T, and U resonances is derived from a comparison of the CERN-IHEP 1970-72 cross sections at 25 and 40 GeV with 1966 missing-mass spectra data at 12 GeV. (L.B.S.)

1347 PION AND K MESON PRODUCTION IN THE MULTIPERIPHERAL MODEL. Amann, R. F. (Syracuse Univ., N. Y.). Nucl. Phys.; B47: No. 2, 610-20(1972).

A simple multiperipheral model, that utilizes only three parameters, two coupling constants and an exponential damping for each momentum transfer is developed and applied to the calculation of inclusive distributions. The pion rapidity and p_1^2 distributions are successfully predicted, as are the energy dependences of strange particle production cross sections. The development of inclusive distributions with increasing energy and possible improvements to the model are discussed. (auth)

1348 ANALYTICITY AS A TEST FOR THE AMBIGUITIES OF $\pi\pi$ PARTIAL WAVES. Gensini, P. (Univ., Lecce, Italy). Nucl. Phys.; B47: No. 2, 462-76(1972).

The consistency with analyticity properties of a recent Chew–Low extrapolation of single-pion production cross sections on hydrogen is explored with the help of phase representations and once subtracted partial wave dispersion relations. An inelastic, "down" solution for the I = 0 S-wave is favored by this analysis at least in the range of c.m. energies from 700 to 1000 MeV. (auth)

1349 MESONS CONSTRUCTED FROM BARYON NONLOCAL FIELDS. Nakamura, Hiroshi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 48: No. 2, 689-90(Aug 1972).

A model is proposed in which the construction of mesons from baryon nonlocal fields has an effect on meson masses without detailed reference to the internal mechanism. (J.F.P.)

1350 VECTOR-MESON DOMINANCE IN PERTURBATION THEORY. Auvil, P. R.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., D; 6: No. 8, 2213-16(15 Oct 1972).

It has been suggested that the formal vector-meson dominance, as contained in the Lagrangian and equations of motion, may not be retained in the perturbation-theory expansion. This question is examined in the context of the Kroll–Lee–Zumino model. Vector-meson dominance is found to be maintained to all orders in perturbation theory. (auth)

1351 NONLINEAR DUALITY CALCULATION OF THE WIDTH OF THE $\pi\pi$ DIFFRACTION PEAK. Balazs, Louis A. P. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 8, 2301-3 (15 Oct 1972).

Regge-exchange amplitudes are inserted into the unitarity relation at intermediate energies. The resulting $\pi\pi$ absorptive part is then required to be dual to one with Pomeranchukon (P), ρ, and f^0 exchange. By assuming ρ and f^0 residue functions consistent with the dual-absorptive model, the P residue near t = 0 is calculated. (auth)

1352 TENSOR APPROACH TO SPIN-ONE MESONS. III. MAGNETIC DIPOLE MOMENT AND ELECTRIC QUADRUPOLE MOMENT. Kyriakopoulos, E. (Democritos Nuclear Research Center, Athens). Phys. Rev., D; 6: No. 8, 2207-12(15 Oct 1972).

In previous papers the massive spin-one mesons were described by means of an antisymmetric second-rank tensor field. In the present paper their free Lagrangian is modified in such a way that when the electromagnetic interactions are introduced by the minimal substitution the mesons get an arbitrary magnetic dipole moment. The addition of other terms in the Lagrangian allows the spin-one mesons to also have an arbitrary electric quadrupole moment. The covariance of the S matrix to order e^2 is achieved by the addition of counterterms. (auth)

1353 MULTIPERIPHERAL MODEL WITH CONSTANT TOTAL CROSS SECTION. Levin, E. M.; Ryskin, M. G. (Inst. of Nuclear Physics, Leningrad). Phys. Lett.; 41B: No. 5, 626-30(30 Oct 1972).

A multiperipheral model is suggested, in which the dependence of the amplitude of production of "n" particles on pair energy and existence of many particles exchanged (ρ, ω, π, A_2, f) is taken into account. Due to these factors a constant total cross section of quite a reasonable magnitude ($\sigma_{\pi\pi}^{tot}$ = 20 mb) for some natural value of coupling constant is obtained. (auth)

1354 IMPROVEMENT OF THE FROISSART BOUND: CROSS-SECTIONS ESSENTIALLY CONSTANT UP TO ISR ENERGIES. Yndurain, F. J. (CERN, Geneva). Phys. Lett.; 41B: No. 5, 591-6(30 Oct 1972).

By simultaneous use of unitarity in all three channels it is shown that total $\pi\pi$ cross sections are bounded by a constant $\approx$ 130 mb, inelastic ones by 31 mb, up to energies of ~300 GeV; and that it is only above that that the logarithmic increase permitted by the Froissart bound could begin to show up. (auth)

1355 SOME EXACT RESULTS ON $\pi\pi$ SCATTERING. Martin, A. (CERN, Geneva). pp 633-42 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The discussion of exact results on $\pi + \pi$ scattering covers basic axiomatic results, absolute limits to the amplitude, positivity and linear constraints on the partial waves, and the construction of an exactly unitary amplitude. (J.F.P.)

Strong (Baryon No. = 1)

1356 (FRNC-TH-265) STUDY OF K^+p SCATTERING UP TO 2,2 GeV/c USING AN INELASTIC N/D METHOD. Chataux, Francois (Paris Univ., Orsay (France)). 1972. 62p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The total K^+p scattering cross section can be divided into two regions: a first region with a particular structure between 0 and 1500 MeV/c; a second region extending beyond 1500 MeV/c in which the cross section remains constant. A large amount of inelasticity occurs after the threshold. The effect of this inelasticity was studied using a model in which the scattering amplitude in the direct channel (obtained from one-particle exchanges in crossed channels) is unitarized using the N/D Frye and Warnock method. The amplitudes obtained by the minimization of the variables lead to a negative $S_{\frac{1}{2}}$ inelastic phase shift at about 720 MeV/c and a positive $P_{\frac{3}{2}}$ phase shift which vanishes at 1.5 GeV/c with an inelasticity of the order of 0.2. This amplitude satisfactorily reproduces the experimental results; this amplitude, however, differs from the results obtained from the phase shift analysis existing above 1500 MeV/c. The existence of a possible Z* resonance having the following quantum numbers: Y = 2, B = 1, and $J^P = 3/2^+$ and a mass of about 1900 MeV is suggested by these results. (France)

1357 (LBL-1038) SOME PHYSICAL CONSEQUENCES OF THE ABFST MULTIPERIPHERAL MODEL. Chan, Chun-Fai (California Univ., Berkeley. Lawrence Berkeley Lab.). 14 Aug 1972. Contract W-7405-eng-48. 60p. Dep. NTIS.

Thesis.

The solution of the Amati–Bertocchi–Fubini–Stanghellini–Tonin multiperipheral integral equation with a narrow-resonance kernel is investigated. First, an approximate scheme that leads to a tractable analytic approximate solution is presented for both the forward and nonforward equations. Next, the exact numerical solutions are displayed for the relevant values of the input parameters: These results serve as a measure of the accuracy of various analytic approximate solutions. The approximate solution present is found to be good to within about 10% in the region of interest. The absolute magnitude of the high energy pseudoscalar-meson (μ)–baryon (B) total cross section is calculated in an SU(3)–symmetric model by using this approximate solution and the approximation that the low energy μB amplitude is dominated by the baryon pole plus the first elastic resonance. The result is comparable to data at the presently highest available energy. The theoretical and phenomenological implications of the high energy off-shell behavior given by this solution are also studied. The improvement of the

model by including the high energy scattering part in the kernel, thus giving a new solution consisting of Regge pole and cut, is briefly discussed. (auth)

1358 (NP-19477) STUDY AND A NEW TABULATION OF FORWARD PION-NUCLEON SCATTERING AMPLITUDES. Internal Note No. 382. Ferrari, E. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 9 Jun 1972. 100p. Dep. NTIS (U. S. Sales Only).

A compilation of π + N data is given including total cross sections for π^+ + p and π^- + p interactions, total cross sections for crossing-even and -odd combinations, subtracted real parts for the crossing-even and -odd combinations, complete crossing-odd and -even amplitudes, and complete amplitudes for π^+ + p and π^- + p scattering. An exhaustive discussion on the treatment of errors is given. (J.F.P.)

1359 PERIPHERAL PRODUCTION OF RESONANCES. Fox, Geoffrey (California Inst. of Tech., Pasadena). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 271-332(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The peripheral cross sections of resonances that cannot be produced by π-exchange are reviewed. Explicitly the four nonets of mesons in the L = 1 quark classification, $J^P = 0^+$ $\pi_N(980)$; 1^+, e.g., A_1, B; 2^+, e.g., A_2 are considered. The constraints of SU_3, exchange degeneracy, factorization, pole extrapolation, Watson's theorem and duality are detailed. The controversial nature of the 0^+ and 1^+ nonets is related to a surprising suppression of their cross sections (which are around 10 μb at 5 GeV/c) in non-diffractive processes. This is explained by a generalized vector meson photon analogy model recently proposed by Kislinger. All differential cross sections for these L = 1 quark states are predicted and it is shown that these mesons are best studied in hypercharge exchange reactions, e.g., $\pi^-p \to Q^0\Lambda$ and $K^-n \to A_1^-\Lambda$. An explanation, using final state interaction theory, of the large background under the Q and A_1 observed in diffractive processes, suggests that quantum numbers of mesons are best studied in non-diffractive reactions of the type mentioned above. (auth)

1360 MESON-NUCLEON CROSS SECTIONS FROM ELON-NUCLEUS COLLISIONS. Goldhaber, Alfred S. (State Univ. of New York, Stony Brook). AIP (Amer. Inst. Phys.) Conf. Proc.; No. 8, 333-9(1972).

From third international conference on experimental meson spectroscopy; Philadelphia, PA. (28 Apr 1972). See CONF-720409.

The status and prospects of elon-nucleus reactions for illuminating meson structure, emphasizing use of coherent processes, are reviewed. Recent observations of kinematically suppressed coherent K*(890) production are discussed. Results for allowed "diffractive" reactions are the main topic. They suggest a picture of diffraction production in hydrogen, in which small constituents of the incident meson are rearranged, and additional mesons are radiated later. (auth)

1361 SYMMETRIES IN THE INCLUSIVE EXCHANGE REGION. Horn, D. (Tel-Aviv Univ., Ramat Aviv, Israel). Nucl. Phys.; B47: No. 2, 559-68(1972).

The idea that an exchange picture may be a valid description of fragmentation in some region $x > x_0 \geq 0.5$ is discussed. Line reversal equations may test the idea. Many relations can be obtained using quark model techniques. Elastic fragmentation results are in agreement with experiment. Applications to resonance production lead to a dual approach. (auth)

1362 STUDY OF ABSORPTIVE CORRECTIONS IN THE REACTION $\pi^-p \to \pi^-\pi^+n$. Kimel, J. D.; Reya, E. (Florida State Univ., Tallahassee). Nucl. Phys.; B47: No. 2, 589-609(1972).

A general absorption model for the three-body final state reaction $\pi^-p \to \pi^-\pi^+n$ is developed for single pion exchange in a framework particularly suitable for including absorptive effects in analyses of $\pi\pi$ scattering in this reaction. The model is used to study the effects of absorption on the differential cross section and on the density matrix elements in the helicity and Gottfried-Jackson frames when the dipion effective mass range covers the ρ-region. The model is also compared with the original (canonical) absorption model of Gottfried and Jackson, with the weak cut model and with the OPE-δ parametrization of absorptive effects. It is found that if strong absorption is operative, excellent fits to the data can be obtained. However, the detailed results are dependent on the nonunique I = 0 s-wave input $\pi\pi$ phase shifts, which mainly affect the s-p interference density matrices, and therefore can be exploited to obtain a favored set of $\pi\pi$ phase shifts. In accord with the data, the model strongly suggests that nonevasive Chew-Low extrapolation techniques should be used in order to measure $\pi\pi$ phase shifts. The weak cut model, on the other hand, is found to be totally inadequate to describe the data in terms of π-exchange and an associated weak cut alone. (auth)

1363 DISTRIBUTION OF THE NUMBER OF CHARGED SECONDARY PARTICLES IN HIGH ENERGY INELASTIC INTERACTIONS. Czyzewski, O.; Rybicki, K. (Inst. of Nuclear Physics, Krakow). Nucl. Phys.; B47: No. 2, 633-41(1972).

It is shown that the experimental data on the prong-number distribution in the inelastic πp and pp collisions can be described by a single formula. (auth)

1364 ENERGY INDEPENDENT COUPLED CHANNEL PHASE SHIFT ANALYSIS FOR THE $\bar{K}N$ SYSTEM. Langbein, W.; Wagner, F. (Max Planck Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B47: No. 2, 477-525(1972).

A phase shift analysis of $\bar{K}N \to \bar{K}N$, $\pi\Sigma$, $\pi\Lambda$ at 40 momenta from 436 to 1226 MeV/c was performed. The single energy solutions found by extensive random searches were linked by a shortest path technique. Apart from the well known resonances in this momentum range, evidence for the existence of four new resonances and two candidates is given. The solution confirms the occurrence of zeros in the amplitude for the process $\bar{K}N \to N\bar{K}$ at fixed u and $K^-p \to \pi^+\Sigma^-$ at fixed t as suggested by dual models. (auth)

1365 REGGE-CUT PHENOMENOLOGY FROM DUALITY DIAGRAMS. Girardi, G.; Lacaze, R.; Peschanski, R.; (and others) (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; B47: No. 2, 445-61(1972).

Using prescriptions based on duality diagrams Regge-Regge and Regge-pomeron-Regge cut corrections to the usual absorption model are studied. In particular a good description of the πN CEX polarization is found. (auth)

1366 DUAL ABSORPTIVE MODEL FOR BACKWARD πN AMPLITUDES. Aye, Tin Maung (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B47: No. 2, 355-64(1972).

A dual absorptive model first proposed by Harari is extended to the backward direction and applied to πN scattering. With plausible assumptions for the real parts of nonperipheral amplitudes, all the qualitative features of the observed differential cross section, polarization and interference terms at 6.0 GeV/c are consistently and simultaneously explained. (auth)

1367 DUAL AMPLITUDES FOR $\pi N \to \rho N$. Chowdhury, A. Roy (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 48: No. 2, 475-89(Aug 1972).

Veneziano-type amplitudes are constructed for $\pi N \to \rho N$. The functional form of the amplitudes is seen to be severely restricted due to the presence of both types of mesons in t-channel. It was found that application of the Veneziano ansatz becomes impossible if $\pi(0^-)$ and $A_1(1^+)$ are taken to be degenerate, a phenomenon also observed in the usual Regge pole theory when conspiracy is taken into account. A further interesting consequence of the dual amplitudes is the prediction of the correct coupling mechanism of ω, π, A_1 trajectories to different helicity states and the automatic incorporation of evasion for the natural parity trajectory. Lastly the dip in the differential cross section at $t = -0.48$ GeV^2 is predicted by the amplitudes, a fact well established over a wide range of values of s. (auth)

1368 DUAL GEOMETRICAL MODEL FOR πN SCATTERING. Kohsaka, Yasutsugu; Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 48: No. 2, 499-512(Aug 1972).

A dual geometrical model has recently been proposed on the basis of a geometrical picture of duality and an extended version of the effective Regge trajectory. This model is applied to πN elastic and charge exchange scattering. Good fits to the data on the differential cross sections (DCS) and polarizations are obtained for a wide range of the incident pion laboratory energy and the square of the momentum transfer (t). In particular, the second dips in the elastic and charge exchange DCS at $t \approx -3$ (GeV/c)^2 and -4 (GeV/c)^2, respectively, can be reproduced by the nonsense wrong signature zeros of the "effective" P′ exchange amplitude without helicity flip and the "effective" ρ exchange amplitude with helicity flip respectively. The Fourier-Bessel transform of the "effective" ρ-exchange amplitude shows an expected peripheral feature in the imaginary part, but a more complicated one in the real part. (auth)

1369 BACKWARD AMPLITUDES FOR MESON-BARYON SCATTERING AND AVERAGE RADIUS OF INTERACTION. Minami, Shigeo (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 546-52(Aug 1972).

On the basis of duality, the region of interaction responsible for meson-baryon scattering in the backward direction is discussed. (auth)

1370 NEW METHOD FOR THE DETERMINATION OF $\pi-N$ SCATTERING AMPLITUDES. Giffon, M.; Laverriere, R. (Univ. Claude Bernad, Villeurbanne, France). Nuovo Cim.; 11A: No. 4, 917-30(21 Oct 1972).

Using the recent measurements of the $R^{\pm}$ rotation parameters, a simple method to determine the various $\pi-N$ scattering amplitudes is proposed. The results are compared with those obtained in previous work and those of the Regge model and FESR. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 1250.

1371 (BNL-17204) SOME ASPECTS OF TWO-BODY AND QUASI-TWO-BODY REACTIONS AT ISABELLE. Field, R. D.; Trueman, T. L. (Brookhaven National Lab., Upton, N. Y.). 22 Aug 1972. 21p. Dep. NTIS.

Some interesting aspects of two-body and quasi-two-body reactions at ISABELLE energies are discussed. The predictions of various models for pp total and elastic differential cross sections including several types of Regge cut parameterizations are examined. Data on inelastic reactions with and without Pomeron exchange are discussed and examined. Estimates of various total and differential cross sections at ISABELLE energies are given. (auth)

1372 (RLO-2041-72) MULTIPLICITY DISTRIBUTION AT 200 GeV AND THE INVERSE-SQUARE FALLOFF. Hwa, R. C. (Oregon Univ., Eugene). 4 Aug 1972. Contract AT-(45-1)-2230. 14p. Dep. NTIS.

The deviation of the multiplicity distribution at 200 GeV from the n^{-2} behavior is explained by a consideration of the exponential damping in momentum transfer for double diffractive excitation processes. From a fit to $\sigma(n_c)$ at 200 GeV, the energy dependences of $\sigma(n_c)$, $\langle n_c \rangle$ and $\langle n_c(n_c-1) \rangle$ are predicted. The agreement with data is good. (auth)

1373 PHENOMENOLOGICAL ANALYSIS OF SINGLE PARTICLE DISTRIBUTIONS. Shen, M. L. (Tusculum Coll., Greeneville, Tenn.). Nucl. Phys.; B47: No. 2, 541-58(1972).

Data of the secondary P_c^2-distribution of different charged prong events with fixed x, those of the same charged prong events with different x, and others in the several ten GeV region are analyzed within the framework of the "emission model." Quantitative agreement is demonstrated, to reaffirm the validity of the model. Various inclusive distributions are derived, and the scaling behaviors are explained in detail. The breakdown of the Feynman scaling near x = 0 is pointed out. The implications of the model are discussed. (auth)

1374 FIXED POLES, UNITARITY, AND DUALITY. APPLICATION TO PROTON-NEUTRON CHARGE EXCHANGE PHENOMENOLOGY. Capella, A. (Laboratorie de Physique Theorique et Particules Elementaires, Orsay, France); Diu, B.; Kaplan, J. M. Nucl. Phys.; B47: No. 2, 365-89(1972).

It is shown that in some cases the partial-wave unitarity relation is not only compatible with the presence of particular fixed poles in the J plane, but also causes these fixed poles to propagate from one reaction to another. It is also shown that, in amplitudes with an exotic s- or u-channel and no pomeron in the t-channel, duality leads to the equality (up to a sign) of the right- and wrong-signature fixed pole residues. These two results together provide a good argument in favor of the presence of some right-signature fixed poles in hadronic reactions. In particular the J = 0 wrong-signature fixed pole found by Dolen, Horn, and Schmid in $\pi^- p \to \pi^0 n$ induces through the above reasoning a right-signature fixed pole at the same value of J in $pn \to np$. This fixed pole is a good candidate for the slowly varying background currently considered to explain the forward spike in $pn \to np$, through a destructive interference with the t-channel pion. In this type of explanation, a definite distribution of the background (whatever its origin may be) among the various amplitudes is required in order to describe the present experimental data, and then a well defined shape is predicted for the forward spike, which should be carefully checked by future experiments. (auth)

1375 DEUTERON DISINTEGRATION BY PIONS, PHOTONS, AND NEUTRINOS BELOW 450 MeV. Wynn, William Michael. Atlanta; Georgia Inst. of Tech. (1972). 197p. University Microfilms Order No. 72-26,303.

Thesis.

An analysis is made of deuteron disintegration by pions, photons, and neutrinos for energy transfers less than 450 MeV. Beginning with pion disintegration, a simple model is used consisting of the Austern isobar amplitude together with nucleon-pole background amplitudes. In the background amplitudes, the vertex invariants, appearing in the dNN vertex function with one off-shell nucleon, are expressed in terms of phenomenological Hulthén-Sugawara deuteron wave functions. The method used here is based on a one-channel-coupling approximation to the Bethe-Salpeter amplitude for the deuteron, and the assumption that antiparticle contributions to relativistic deuteron processes are already incorporated in phenomenological wave functions. With the isobar amplitude truncated with a cut-off momentum similar to that used previously, excellent results are obtained for the total and differential cross sections. (TSS) (Diss. Abstr. Int., B)

1376 DIFFRACTION MODEL OF PROTON-PROTON SCATTERING. Kawasaki, Mamoru; Yonezawa, Minoru (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 691-2(Aug 1972).

The energy dependence of the slopes of the forward peaks in proton-proton scattering was previously discussed using a diffraction model. The problem of the hypothetical isobar mass having a decisive role in the phenomenon of the threshold effect in the shrinkage behavior in this model is discussed. It is found that the slowly increasing isobar mass improves the fit to the data. (J.F.P.)

1377 NEW SCALING LAW BASED ON THE HYDRODYNAMICAL MODEL OF PARTICLE PRODUCTION. Carruthers, P.; Duong-Van, M. (Cornell Univ., Ithaca, N. Y.). Phys. Lett.; 41B: No. 5, 597-601(30 Oct 1972).

It is shown that Landau's hydrodynamical model of particle production accounts for many features of pion production in proton-proton collisions observed in recent experiments. A new energy-dependent scaling is proposed, in terms of which the distribution of secondaries at various energies falls on a universal curve having no adjustable parameters. (auth)

1378 200 GeV MULTIPLICITY DISTRIBUTION AND SCALING. Olesen, P. (Univ. of Copenhagen). Phys. Lett.; 41B: No. 5, 602-4(30 Oct 1972).

The charged particle multiplicity distribution from 200 GeV pp interactions recently obtained at NAL is compared to a scaling equation for this distribution proposed by Koba, Nielsen and Olesen. The results indicate that this type of scaling is rather well satisfied as one goes from 28.5 GeV to 200 GeV. On the basis of the scaling equation the ISR multiplicity distribution is predicted from the 200 GeV data. (auth)

1379 EFFECT OF PP-CUT CONTRIBUTION ON THE DIFFRACTION CONE SLOPE. Ter-Martirosyan, K. A. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 41B: No. 5, 621-2(30 Oct 1972).

The effect of the PP-cut contribution including enhanced ones on the diffraction cone slope in the region of small $|t|$ and of very high energies $E = E_{lab}$ is discussed in connection with the CERN data on $b(E,t)$ for pp scattering at $E \sim 10^3$ GeV. (L.B.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 1416.

1380 SYMMETRY PRINCIPLES IN PHYSICS. Lee, T. D. (Columbia Univ., New York). pp 306-19 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The foundation of symmetry principles is examined. The connection between three fundamental aspects of a symmetry is illustrated: the assumption of a nonobservable, the implied invariance under the connected mathematical transformation, and the physical consequence of a conservation law. Asymmetries and observables, time reversal, and complementarity of symmetry violations are further discussed. (L.B.S.)

1381 CLASSIFICATION OF SEMISIMPLE SUBALGEBRAS OF SIMPLE LIE ALGEBRAS. Lorente, M. (Univ., Madrid); Gruber, B. J. Math. Phys.; 13: No. 10, 1639-62(Oct 1972).

An explicit classification of the semisimple complex Lie subalgebras of the simple complex Lie algebras is given for algebras up to rank 6. The notion of defining vector, introduced by Dynkin and valid for subalgebras of rank 1, was extended to the notion of defining matrix, valid for any semisimple subalgebra. All defining matrices were determined explicitly, which is equivalent to the determination of the embeddings of the generators of the Cartan subalgebra of a semisimple subalgebra in the Cartan subalgebra K of the simple algebra containing this subalgebra. Moreover, the

embedding of the root system of the subalgebras in the dual space K* of an algebra is given for all subalgebras. For the S-subalgebras of the simple algebras (up to rank 6), the embedding of the whole subalgebra in an algebra is given explicitly. In addition, the decomposition (branching) of the defining (fundamental) and adjoint representations of an algebra with respect to the restriction to its S-subalgebras was determined. A brief review of Dynkin's theory of the classification of the semisimple Lie subalgebras of the simple Lie algebras is given. No proofs are repeated, and at places where concepts have been extended and new results derived, merely an indication for their proof is given. A prescription for a classification of semisimple subalgebras of the simple Lie algebras of rank exceeding 6 is given. Later explicit expressions are given for the index of an embedding of a simple Lie subalgebra in a simple Lie algebra. These expressions are valid for the classical Lie algebras of arbitrary rank as well as for the exceptional Lie algebras. (auth)

1382 $U_{n,1}$ AND IU_n REPRESENTATION MATRIX ELEMENTS. Wolf, Kurt Bernardo (Univ., Mexico, Mexico City). J. Math. Phys.; 13: No. 10, 1634-8(Oct 1972).

A realization of the $U_{n,1}$ and IU_n groups as multiplier representations of the space of functions on the U_n group manifold is constructed. Making use of the orthogonality and completeness of the U_n unitary irreducible representation matrix elements (UIRME's) one is able to express the $U_{n,1}$ boost and IU_n translation matrix elements (the generalized Wigner d-functions) of the principal series of UIR's as an integral over a compact domain (unit disc) of two U_n d-functions, phases, and the multiplier. This is an extension to the unitary groups of a method previously used [J. Math. Phys. 12, 197 (1971)] to find the SU_n, $SO_{n,1}$, and ISO_n UIRME's in a recursive fashion. A number of symmetry properties, the asymptotic (Regge-like), and contraction ($U_{n,1} \rightarrow IU_n$) behavior of these functions are established. (auth)

1383 PROPERTIES OF LORENTZ COVARIANT ANALYTIC FUNCTIONS. Stapp, Henry P. (Univ. of California, Berkeley). J. Math. Phys.; 13: N. 10, 1551-68(Oct 1972).

A theorem is proved that asserts, roughly, that a function that is real Lorentz covariant anywhere is complex Lorentz covariant everywhere in its domain of regularity. It is also shown that the analytic continuation of a scattering function from a regularity domain in the physical region of a given process along all paths generated by complex Lorentz transformations leads to a function that is single-valued in the neighborhood of all these paths. Applications are discussed. The results derived constitute necessary preliminaries to a discussion of the analytic structure of scattering functions given previously. (auth)

1384 REDUCTION OF THE POINCARE GROUP WITH RESPECT TO THE LORENTZ GROUP. MacDowell, W. W.; Roskies, Ralph (Yale Univ., New Haven). J. Math. Phys.; 13: No. 10, 1585-92(Oct 1972).

The representations of the Poincaré Group for spinless particles, reduced with respect to the Lorentz subgroup, are investigated. They involve the principal series of representations of SL(2,C) and use is made of a basis, introduced by Gel'fand in which the states are labeled by a complex number z. The transformation matrices relating to the Wigner basis are derived. The matrix elements of the momentum operators are obtained. The general form of the S matrix in the new basis is discussed. This basis may be relevant for a field theoretical description of the Veneziano model. (auth)

1385 GENERALIZED EXCHANGE OPERATORS FOR SU(n). Partensky, A. (Universite Claude Bernard de Lyon). J. Math. Phys.; 13: No. 10, 1503-10(Oct 1972).

By following the work of Biedenharn the k-particles generalized exchange operators (g.e.o.'s) were redefined and their properties studied. By a straightforward but cumbersome calculation the expression was derived in terms of the SU(n) Casimir operators of the 2-, 3-, or 4-particle g.e.o. acting on the A-particle states which span an irreducible representation of the grown SU(n). A striking and interesting result is that the eigenvalues of each of these g.e.o.'s do not depend on the n in SU(n) but only on the Young pattern associated with the irreducible representation considered. For a given g.e.o., the eigenvalues corresponding to two conjugate Young patterns are the same except for the sign which depends on the parity of the g.e.o. considered. Some related problems and, more specifically, a method of obtaining the eigenvalues of Gel'fand invariants in a new and simple way are considered. (auth)

1386 MASSIVE PARTICLES AND THE SPONTANEOUS BREAKDOWN OF DILATION INVARIANCE. Bose, S. K.; McGlinn, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 6: No. 8, 2304-6(15 Oct 1972).

In a recent paper an argument was given that the conservation of dilation current (vanishing of the trace of the stress-energy tensor) implied that all single-particle states have zero mass. The form of the dilation current was subsequently criticized. In this note it is shown that with a quite general form of dilation current the result is unchanged. (auth)

1387 GALILEAN STRUCTURE OF THE POINCARE GROUP ON THE LIGHT-CONE. Hu, B. (Cornell Univ., Ithaca, N. Y.). Nuovo Cim.; 11A: No. 4, 937-42(21 Oct 1972).

It is observed that the isomorphism between the Poincaré subgroup in the L.C. (light-cone) co-ordinates and the two-dimensional Galilean group can be trivially extended to higher dimensions. The case of five dimension is explicitly shown, and the generalization to any finite dimension n (>2) is immediate. (auth)

Applications (Electromagnetic and Weak)

1388 SCALAR MESONS AND SYMMETRY BREAKING IN SU(3) x SU(3) NON-LINEAR MODELS. Dondi, P. H.; Eliezer, S. (Cambridge Univ., Eng.). Nucl. Phys.; B47: No. 2, 390-6(1972).

For effective nonlinear Lagrangian it is shown that it is possible to get $f_K/f_\pi \neq 1$ by introducing the scalar mesons. Approximately SU(3) invariant physical states are consistent only with approximate SU(2) × SU(2) symmetry ($\epsilon_8 \simeq -\sqrt{2}\,\epsilon_0$) of the Lagrangian. (auth)

1389 NEW APPROACH TO $\eta \rightarrow 2\gamma$ DECAY AND MODELS OF ELEMENTARY PARTICLES. Maki, Ziro (Kyoto Univ.); Maskawa, Toshihide; Umemura, Isao. Progr. Theor. Phys. (Kyoto); 48: No. 2, 596-606(Aug 1972).

A new approach to the two-photon decays of pseudoscalar mesons is proposed. In the case of spontaneously broken chiral U(4) ⊗ U(4) symmetry, the theory reproduces the experimental data on $\eta \rightarrow 2\gamma$ almost completely under suitable parameters chosen consistently with the possible existence of heavy charmed bosons above (1.5 ~ 2.0)GeV. It tempts one to favor the fractionally charged quartet model with lepton-baryon symmetry, although other alternatives, i.e., the quark- or three-triplet models, are not to be disproved within the approximations. (auth)

1390 WEAK INTERACTIONS. CP-VIOLATION. Lobashev, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). pp 262-95 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The review of weak interactions covers the principal characteristics of current–current weak interactions, K meson spectroscopy with CP conservation, baryon decays, $\Delta Q = \Delta S$ rule, CP violation, and processes involving high energy muons and neutrinos and the search for metastable particles. (J.F.P.)

1391 WEAK INTERACTIONS AND CP VIOLATION. Kobzarev, I. Yu. (Inst. of Theoretical and Experimental Physics, Moscow). pp 544-63 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

The review of CP violation in weak interactions covers leptonic decays of hadrons, the $\Delta T = \frac{1}{2}$ rule and P-odd nuclear forces, CP violation, high energy weak interactions, and W bosons. (J.F.P.)

Applications (Strong)

Refer also to abstracts 1253 and 1409.

1392 (DESY-72/41) ESTIMATION OF THE VACUUM SU_3 BREAKING IN THE $(\bar{3},3) + (3,\bar{3})$ MODEL. Cornwell, D. T.; Eimerl, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jul 1972. 22p. Dep. NTIS (U. S. Sales Only).

It is pointed out that the usual $(\bar{3},3) + (3,\bar{3})$ model of chiral symmetry breaking and recent mathematical analyses of the parameters in K_{l3} decay restrict the possible value of $\Delta_K(0)$, the generalized propagator of the strangeness-changing vector divergence at zero four momentum squared. The requirement of approximate SU_3 invariance of the vacuum reduces the allowed range of values still more. When this parameter is then evaluated using fits to the Kπ-phase shift data, it is found to fall outside the available interval. Therefore it is concluded that, within this scheme, the Kπ scattering data is incompatible with the SU_3 symmetry of the vacuum. Possible ways of avoiding this conclusion, or of altering the scheme, are considered. (auth)

1393 REGGE PHENOMENOLOGICAL STUDIES OF SU(3), DUALITY, AND CUT-CORRECTED EXCHANGE DEGENERACY. Gage, Douglas Whitney. Tempe, Ariz.; Arizona State Univ. (1972). 71p. University Microfilms Order No. 72-23,387.

Thesis.

Three independent but related studies of SU(3), duality, and cut-corrected exchange degeneracy are presented: A multiple-scattering model for Regge pole-Regge pole cuts is developed and applied in a fit to KN and $\bar{K}N$ charge exchange differential cross section data. It is found that such cuts can quantitatively account for the sign, magnitude, and energy dependence of the cross section difference between these line reversed reactions at moderate energies. The model is extended to pion-nucleon charge exchange, eta production, and a line reversed pair of hypercharge exchange reactions ($\pi^+p \to K^+\Sigma^+$ and $K^-p \to \pi^-\Sigma^+$). The hypercharge exchange cross section difference is quantitatively accounted for by a simple crossing symmetric parametrization of unequal absorption effects due to higher mass intermediate states. The rapid energy dependence of the $\pi^-p \to K^+\Sigma^-$ (exotic t-channel) forward differential cross section is investigated in the context of a simple Veneziano model. The quantitative agreement achieved suggests that this feature of exotic exchange reactions is due to a direct-channel resonance overlap effect, which is a general feature of such dual models. (Diss. Abstr. Int., B)

1394 TOLLER POLE ANALYSIS OF DIP STRUCTURE IN TWO-BODY HADRONIC COLLISIONS. Saleem, M.; Khan, A. R. (Punjab Univ., Lahore). Progr. Theor. Phys. (Kyoto); 48: No. 2, 566-73(Aug 1972).

It is shown that, on O(3,1) symmetry model, for all hadron–hadron near-forward scattering, dips in differential cross sections can occur only at $\alpha = 0$ and $\alpha = -1$, while for near backward meson-baryon scattering dips can occur only for $\alpha = -1/2$, provided only leading terms in the expansion of helicity amplitudes are retained and slow variation and good behavior of Toller's residues is assumed. A technique is also developed by which the values of α at which each of the reduced amplitudes disappears can be found without making explicit calculations. This enables one to explain the dip structure without making lengthy calculations. (auth)

1395 CONTENT OF THE (3,3*) + (3*,3) MODEL IN THE POLE-DOMINANCE APPROXIMATION. Olshansky, R. (Laboratoire de Physique Theorique et Hautes Energies, Paris). Phys. Rev., D; 6: No. 8, 2243-9(15 Oct 1972).

The content of the (3,3*) + (3*,3)-symmetry-breaking model (including an isospin-violating interaction) is explored by using the spin-zero meson-dominance approximation for two- and three-point functions. By fully exploiting the pole-dominance approximation it is shown that a number of the assumptions made by Gell–Mann, Oakes, and Renner are unnecessary. The results indicate that the Hamiltonian is nearly SU(2) × SU(2)-symmetric and that a small isospin-violating interaction is present. One can conclude that (3,3*) + (3*,3)-symmetry-breaking models with Hamiltonians very different from this must contain large violations of pole dominance. (auth)

Field Theories

Quantum Field Theory

Refer also to abstracts 1290, 1311–1313, 1316, 1334, 1386, and 1441.

1396 (CF-LPAM-72-8) EFIMOV–FRADKIN FORMALISM FOR NONPOLYNOMIAL INTERACTIONS OF AN HARMONIC OSCILLATOR. I. INTERACTIONS REPRESENTED BY ENTIRE FUNCTIONS. Houard, J. C.; Teffo, J. L. (College de France, Paris. Laboratoire de Physique Atomique et Moleculaire). 1972 47p. Dep. NTIS (U. S. Sales Only).

The Efimov–Fradkin formalism, devised for nonpolynomial interactions in field theory, is reviewed in the case of zero dimensional space, that is when the field variable is replaced by the position coordinate of an harmonic oscillator, and a rigorous proof of the correctness of that formalism is given in the case where the interaction Hamiltonian is an entire function of the coordinate. (France)

1397 (CNRS-CPT-72-P-453) REDUCE APPROACH TO THE CALCULATION OF FEYNMAN DIAGRAMS. Calmet, J. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Mar 1972. 16p. (CONF-720423-5). Dep. NTIS (U. S. Sales Only).

From 1st European conference on computational physics; Geneva, Switzerland (10 Apr 1972).

A brief survey of two existing REDUCE programs (by Campbell–Hearn and by Calmet) dealing with the algebraic computation of Feynman diagrams is given. Work in progress on a more general approach to this problem is also discussed. Finally the impact of REDUCE in high energy physics is stressed. (France)

1398 (JINR-E2-6642) CONFORMAL INVARIANT QUANTUM FIELD THEORY. Lecture Notes. Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 52p. Dep. NTIS (U. S. Sales Only).

Lectures are presented reviewing recent development in constructive conformal invariant quantum field theory. Conformal covariance of the fields with fixed scale dimensions allows one to determine the physical propagators and vertex functions uniquely up to a multiplicative constant. These "dressed" propagators and vertices are used to construct a skeleton graph expansion for the n-point Green functions ($n \geq 4$). It is proven that the skeleton diagrams are free of ultraviolet divergences. The proof (which is an improved version of the argument given in the preprint of G. Mack and the author) also applies to the integrals in the renormalized Schwinger–Dyson equations for the 3-point functions. (auth)

1399 (NP-19475) MULTIPLICATIVE RENORMALIZATION GROUP AND THE CRITICAL BEHAVIOUR IN $d = 4 - \epsilon$ DIMENSIONS. Internal Note No. 384. Di Castro, C. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 20 Jun 1972. 10p. Dep. NTIS (U. S. Sales Only).

The critical behavior is computed in the multiplicative renormalization group equations for $(|\psi|^2)^2$ field theory in d dimensions for a system of bosons interacting via a two-body point potential above the critical temperature. (J.F.P.)

1400 (ORO-3992-112) PARTICLES TRAVELING FASTER THAN LIGHT. Sudarshan, E. C. G. (Texas Univ., Austin. Center for Particle Theory). 1971. 21p. (CPT-166). Dep. NTIS.

A review of tachyons is presented covering bradyon, luxon, and tachyon classes of objects, relativity theory, the strange world of tachyons, tachyon paradoxes, the switching principle for resolution of tachyon paradoxes, causality, tachyon fields, and the existence of tachyons. (J.F.P.)

1401 (RPP/T-29) INTRODUCTION TO GAUGE-FIELDS AND RENORMALIZABLE THEORIES OF CHARGED VECTOR MESONS. Taylor, J. C. (Rutherford High Energy Lab., Chilton (England)). 1972. 49p. Dep. NTIS (U. S. Sales Only).

An introduction is presented to nonabelian gauge field theories (and their Feynman graphs), which form the basis of recent renormalizable theories of weak and electromagnetic interactions. The subject is covered in sections: why massive vector mesons are generally not renormalizable; photons; Yang-Mills fields; Feynman rules for Y-M fields are not simple; Feynman path-integral formalism; path-integral formalism for Y-M fields; Feynman rules for Y-M; unitarity of the Y-M rules; the Higgs mechanism; Goldstone's theorem; more realistic models of weak and electromagnetic interactions; properties of and problems with the models; finite mass-differences; Bell-Jackiw-Adler anomalies. Also off-shell Ward identities for Y-M, and renormalization, respectively are included. A list of references is provided. (UK)

1402 RIGOROUS RESULTS FROM FIELD THEORY AND UNITARITY. Martin, A. (CERN, Geneva). pp 22-61 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A review is first given of the basic field theoretical results concerning the analytic properties of scattering amplitudes. Positivity and extended dispersion relations are next discussed. The remaining topics cover upper bounds on the high-energy amplitudes, the question of the Pomeranchuk theorem, lower bounds on the forward amplitude, and lower bounds for large momentum transfers. (L.B.S.)

1403 PARTICLES AS NORMAL MODES OF AN UNDERLYING GAUGE FIELD THEORY. Cooper, Fred (Yeshiva Univ., New York); Chodos, Alan. Lect. Theor. Phys.; 14A: 349-73 (1972).

It is suggested that the physical properties of the existing bosons and fermions are well approximated by considering the particles as normal modes of an underlying field theory possessing gauge invariance of the second kind. In the framework of the narrow resonance approximation to scattering, a particle starts out in a given normal mode and absorbs and emits external quanta with corresponding excitation and de-excitation of the underlying field theory. The vertices are obtained by postulating that the external quanta couple to appropriate currents inherent in the Lagrangian. Rules

can then be given for constructing N-point functions in the narrow resonance approximation. For a system consisting of only the π and δ trajectories, it is shown that it is possible to construct currents obeying the chiral SU(2) × SU(2) algebra. (L.B.S.)

1404 INTRODUCTION TO THE CHARACTERISTIC INITIAL VALUE PROBLEM IN QUANTUM FIELD THEORY. Domokos, G. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-4076. Lect. Theor. Phys.; 14A: 375-98(1972).

A brief introduction is given to a new approach to quantum field theory. The physical motivation comes from an attempt to formulate the parton models and additive quark models in a consistent way and to extend them to a full dynamical scheme. The lectures cover the following topics: intuitive considerations; elementary theory of characteristics; kinematics, spinor technique; elementary properties of the characteristic initial value problem in quantum field theory; and light-like quark model. (L.B.S.)

1405 FINITE QUANTUM ELECTRODYNAMICS IN EIGHTH ORDER. Samuel, Mark A. (Oklahoma State Univ., Stillwater). Nucl. Phys.; B47: No. 2, 526-40(1972).

The question of whether or not a finite theory of quantum electrodynamics exists is known to be equivalent to an eigenvalue condition on the square of the bare charge $\psi(e_0^2) = 0$. Recently, it has been shown that the zeroes of ψ and a simpler function f (which is determined from a model) coincide. Both ψ and f are known to sixth order. The relation between ψ and f in eighth order is considered. It is shown explicitly that the expansion for the unrenormalized photon Green's function in terms of f, and the Gell-Mann-Low series agree to this order. Then the difference function $D = \psi - f$, and the eigenvalue equation $D(e_0^2) = 0$ are considered as a condition for the existence of finite Q.E.D. An expression for D in eighth order is obtained, and the relation between ψ and f to second order in f is developed. (auth)

1406 PREFACE TO RELATIVISTIC QUANTUM MECHANICS. Corones, James Peter. Boston; Boston Univ. (1972). 143p. University Microfilms Order No. 72-25,257.

Thesis.

This work clarifies the conceptual framework necessary to develop a theory of relativistic quantum mechanics. Quantum mechanics is understood as the quantum theory of a single particle interacting at most with a potential. Since special relativity requires that the equations of a physical theory treat all the space-time dimensions in a uniform way, it is necessary to prepare a framework which is more general than Hamiltonian dynamics but, of course, contains Hamiltonian dynamics as a special case. If the idea that particles and antiparticles propagate in different directions in time is accepted then even Hamiltonian dynamics must be reconsidered as a basis for formulating equations of motion. A system that can be interpreted as having the essential features of bivalent propagation is one-dimensional steady state quantum scattering. This is treated extensively. A more general, abstract system that reflects these properties is an n-port "black box" with input and output at every port. These systems are considered and methods of combining boxes are discussed and a differential equation for changes in the operator that maps from input to outputs with respect to small change in inputs and outputs is derived. The equations derived for the above cases can be interpreted with a generalization of the canonical formalism. To do this a symplectic space is defined as well as null subspaces and symplectic mappings. With these structures it is shown that all the results derived for the one-dimensional quantum system discussed, as well as for the black boxes can be given a symplectic interpretation. For example, boxes are composed by a variational procedure and the differential equation is a generalization of the Hamilton-Jacobi equation. (Diss. Abstr. Int., B)

1407 $\lambda\varphi_2^4$ QUANTUM FIELD THEORY WITHOUT CUTOFFS. IV. PERTURBATIONS OF THE HAMILTONIAN. Glimm, James (New York Univ., New York); Jaffe, Arthur. J. Math. Phys.; 13: No. 10, 1568-84(Oct 1972).

An inductive method is used to estimate the shift δE in the vacuum energy, caused by a perturbation δH of the $P(\varphi)_2$ Hamiltonian H. This proved that if δH equals the field bilinear form $\varphi(x,t)$, then δE is finite. It is shown that the vacuum expectation values of products of fields (Wightman functions) exist and are tempered distributions. They determine, via the reconstruction theorem, essentially self-adjoint field operators $\varphi(f)$, for real test functions $f \in S(R^2)$. Also the perturbation of the $P(\varphi)_2$ Hamiltonian is bounded by a polynomial $(P_1(\varphi))(h) = \delta H$, so long as $P + P_1$ is formally positive. In that case, and with $||h||_\infty \leq 1$, δE is bounded by const (1 + diam supp h). (auth)

1408 DUAL QUARK THEORY VIEWED AS A QUANTIZATION OF THE THIRRING MODEL. Kikkawa, Keiji (City Coll. of New York, N. Y.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 625-32(Aug 1972).

The dual quark theory is discussed as a second quantization of the Thirring-type model in a two-dimensional Euclidean space. The dual amplitude can be made to be invariant under the conformal transformation. The tachyons in the two-pion channels are still decoupled for an arbitrary pion intercept. (auth)

1409 ASSOCIATION OF THE SAKATA-TAKETANI (FESHBACH-VILLARS) FIELD WITH THE KEMMER FIELD, UNDER SYMMETRY BREAKING. Fischbach, Ephraim (Purdue Univ., Lafayette, Ind.); Nieto, Michael Martin; Scott, C. K. Progr. Theor. Phys. (Kyoto); 48: No. 2, 574-94(Aug 1972).

Both the original and two new derivations of the covariant Sakata-Taketani "system of equations", and of the identical relativistic, but noncovariant Sakata-Taketani (S-T) and Feshbach-Villars (F-V) equations are discussed. (These last two equations were originally derived from the Duffin-Kemmer-Petiau and Klein-Gordon (K-G) equations, respectively.) By considering the scaling properties of the Kemmer, K-G and S-T fields, it is concluded that in the presence of SU(3) symmetry breaking the S-T field can no longer be associated with both the Kemmer and K-G fields, but only with the Kemmer field. This has important conceptual implications concerning the particle-anti-particle nature of mesons. (auth)

1410 EIKONAL METHODS IN CLASSICAL BOUND-STATE PROBLEMS AND INTENSE-FIELD ELECTRODYNAMICS. Dittrich, Walter (Univ., Tuebingen, Ger.). Phys. Rev., D; 6: No. 8, 2094-2104(15 Oct 1972).

A systematic treatment of bound-state problems is presented, using the hydrogen spectrum as a guide. The well-known binding energies are identified as poles of a subclass of Feynman diagrams, after eikonalization and the infinite-mass limit have been performed on the heavier of the two particles. Furthermore, the problem of an electron in a prescribed intense monochromatic field is studied with eikonal methods. The Green's function is examined in detail for the particular case of a scalar electron, and finally related to a spinor electron in a plane-wave field. Schwinger's functional methods are employed throughout. (auth)

1411 REPRESENTATION OF A THEORY OF CURRENTS. Perrin, Robert (Northeastern Univ., Boston). Phys. Rev., D; 6: No. 8, 2089-93(15 Oct 1972).

A canonical representation is given for a recently proposed theory of currents. The solutions differ from the analogous representation of Sugawara's theory in that one less constraint is present. This allows one to break the additional O(4) symmetry which would otherwise be present. The difficulties in obtaining perturbative solutions are the same in both theories. (auth)

1412 NEW EXACT SOLUTION FOR THE GRAVITATIONAL FIELD OF A SPINNING MASS. Tomimatsu, Akira (Kyoto Univ.); Sato, Humitaka. Phys. Rev. Lett.; 29: No. 19, 1344-5(6 Nov 1972).

A solution for the gravitational field is presented, which reduces to one of the Weyl metrics in the limit of angular momentum $J = 0$ and reduces to the Kerr metric in the limit of $J = m^2$. (auth)

1413 SPEED OF LIGHT FROM DIRECT FREQUENCY AND WAVELENGTH MEASUREMENTS OF THE METHANE-STABILIZED LASER. Evenson, K. M. (National Bureau of Standards, Boulder, Colo.); Wells, J. S.; Petersen, F. R.; (and others). Phys. Rev. Lett.; 29: No. 19, 1346-9(6 Nov 1972).

The frequency and wavelength of the methane-stabilized laser at 3.39 μm were directly measured against the respective primary standards. With infrared frequency synthesis techniques, one obtains $\nu = 88.376\,181\,627(50)$ THz. With frequency-controlled interferometry, $\lambda = 3.392\,231\,376(12)$ μm is found. Multiplication yields the speed of light $c = 299\,792\,456.2(1.1)$ m/sec, in agreement with and 100 times less uncertain than the previously accepted value. The main limitation is asymmetry in the krypton 6057-Å line defining the meter. (auth)

1414 THEORY OF CURRENTS. Perrin, Robert (Northeastern Univ., Boston). Phys. Rev., D; 6: No. 8, 2085-9(15 Oct 1972).

A modification of the Sugawara model is presented in which all components of the currents have scale dimension three, all requisite Schwinger terms are present in the stress-tensor commutators, and in which the trace of the stress tensor is a sum of terms of fixed scale dimension. (auth)

1415 SECOND-ORDER CORRECTION TO THE FIRST-ORDER QUANTUM-MECHANICAL TREATMENT OF AN ELECTRON UNDERGOING SYNCHROTRON RADIATION. White, D. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 6: No. 8, 2080-5 (15 Oct 1972).

A relativistic electron moving transversely to a homogeneous and constant magnetic field is considered. The energy states of

the electron are assumed to be quasicontinuous, and the initial electron energy, E_n, is assumed to be such that $(E_n/mc^2)^2 \gg 1$. It is shown that for the above conditions the second-order correction to the first-order transition rates from state n to some lower state n′ is of order α regardless of n−n′, E_n, or magnetic field H. (auth)

1416 COMMENT ON THE BREAKDOWN OF DILATATION INVARIANCE. Aurilia, Antonio; Takahashi, Yasushi (Univ. of Alberta, Edmonton). Phys. Rev., D; 6: No. 8, 2294-8(15 Oct 1972).

On the basis of our previous results concerning the breakdown of dilatation invariance it is found that two large classes of models in quantum field theory may lead to the same observable quantities in spite of their different properties under scale transformation. Although the conditions of equivalence have long been known their relevance in the new context of the dilatation transformation is emphasized. The equivalence in question leads to the same physical masses, observable coupling constants, and, possibly to the same energy-momentum tensors associated with the asymptotic fields in the two theories. It is suggested that the arbitrariness in the choice of an interpolating field is a key point for the equivalence of the two theories. Our analysis also underlines the difference between the notions of physical dimension and scale dimension of a field operator. (auth)

1417 SINGULARITY STRUCTURE OF THE DOUBLE-REGGE VERTEX IN THE NONPLANAR VENEZIANO MODEL. Roth, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 8, 2274-6(15 Oct 1972).

Previously studied models of the double-Regge vertex have exhibited only right-hand cuts in the Toller variable. It is shown that the nonplanar dual model of Mandelstam has left-hand cuts in the Toller variable. This function is also used to calculate all possible total (planar plus nonplanar) Reggeon−Reggeon−particle vertex functions. (auth)

1418 TENSOR APPROACH TO SPIN-ONE MESONS. II. QUANTIZATION. Kyriakopoulos, E. (Democritos Nuclear Research Center, Athens). Phys. Rev., D; 6: No. 8, 2202-7 (15 Oct 1972).

The spin-one mesons were described previously by means of an antisymmetric second-rank tensor field. The quantization is performed in the free-field case, and also in the interacting-field case. (auth)

1419 GAUGE-FIELD THEORY OF PARTICLES. II. FERMIONS. Cooper, Fred (Yeshiva Univ., New York); Chodos, Alan. Phys. Rev., D; 6: No. 8, 2168-83(15 Oct 1972).

Classes of Lagrangians which describe families of fermions containing an infinite number of particles are constructed. The Lagrangians depend on Rarita−Schwinger fields with k Lorentz indices, k = 1, 2, . . . , which have bilinear interactions among themselves. These Lagrangians are invariant under guage transformations of the second kind. The physical states appear as the normal modes of these field theories, and by suitable choices of the masses of the underlying gauge fields, the physical fermions can be made to lie on linearly rising Regge trajectories. The currents have nontrivial diagonal matrix elements, and also have matrix elements between states of different spin. By considering time-ordered products of currents between single-particle states, on- and off-mass-shell N-point functions in the narrow-resonance approximation are constructed. Specifically, rules are given for calculating πN scattering and inelastic electron scattering in that approximation. (auth)

1420 PERTURBATION LAGRANGIAN THEORY FOR DIRAC FIELDS: WARD–TAKAHASHI IDENTITY AND CURRENT ALGEBRA. Lam, Yuk-ming P. (Univ. of Pittsburgh). Phys. Rev., D; 6: No. 8, 2161-7(15 Oct 1972).

In a class of Lagrangian field theories for Dirac spin-½ particles, the Bogoliubov−Parasiuk−Hepp renormalization scheme provides a proof of the operator forms of Euler−Lagrange equations of motion, Noether's theorem, and Ward−Takahashi identities. Time-ordered products for some derivatives of Dirac fields can only be defined with special care in terms of Feynman graphs. Current-algebra Ward−Takahashi identities are obtained if $L^{\text{derivative}}$ is invariant under the algebra; however, Schwinger terms are absent from these identities. (auth)

1421 PERTURBATION LAGRANGIAN THEORY FOR SCALAR FIELDS: WARD–TAKAHASHI IDENTITY AND CURRENT ALGEBRA. Lam, Yuk-ming P. (Univ. of Pittsburgh). Phys. Rev., D; 6: No. 8, 2145-61(15 Oct 1972).

Under the assumption that the time-ordered products are given by Feynman rules with Bogoliubov's renormalization scheme, it is shown that the operator forms of Euler−Lagrange equations of motion and Noether's theorem for a wide class of perturbation Lagrangian theories for scalar fields are valid. Ward−Takahashi identities for currents in Noether's theorem are also proved without recourse to equal-time commutators, and current-algebra results follow naturally in a subclass of Lagrangian field theories. Covariant Schwinger terms are present in these identities and their nature is determined. (auth)

1422 QUANTIZATION OF THE SPIN-3/2 FIELD IN THE PRESENCE OF INTERACTIONS. I. Kimel, J. D.; Nath, L. M. (Florida State Univ., Tallahassee). Phys. Rev., D; 6: No. 8, 2132-44(15 Oct 1972).

The electrodynamics of spin-3/2 particles is discussed. In particular, the spin-3/2 field in the presence of the minimal electromagnetic interaction is quantized by using the Yang−Feldman formalism. The Hamiltonian for this system is obtained explicitly and the commutation relations derived are shown to be consistent with Heisenberg's equations of motion. In this formalism, the condition for the anticommutator between a spin-3/2 field and its Hermitian conjugate to be positive definite is simple to formulate. (auth)

1423 ANOMALIES OF BILOCAL OPERATORS. Schnitzer, Howard J. (Brandeis Univ., Waltham, Mass.). Contract AT(11-1)-3230. Phys. Rev., D; 6: No. 8, 2118-32(15 Oct 1972).

Methods are described for determining the leading light-cone singularities of bilocal operators in perturbation theory. Specific results are obtained for the bilocal operator $T^*\{\psi(x)\bar{\psi}(0)\}$ in the scalar-gluon model in lowest nontrivial order, with the finding that the q-number part of the bilocal operator is singular in the limit $x^2 \to 0$, contrary to usual assumptions. A description of the anomalies of deep-inelastic scattering is given in terms of canonically determined bilocal operators, with due attention to the singular nature of these operators, and with no recourse to new bilocal operators not present at the canonical level. Applications to the Schwinger-term sum rule and electromagnetic mass operator are made, with the same conclusions. (auth)

1424 SCHWINGER'S PROPER-TIME METHOD AND THE EIKONAL APPROXIMATION. Dittrich, Walter (Univ., Tuebingen, Ger.). Phys. Rev., D; 6: No. 8, 2104-12(15 Oct 1972).

Eikonal techniques are used to present an alternative treatment of the electron's Green's function in the presence of a plane-wave field. After studying the propagation of an electron in a prescribed electromagnetic field the corresponding Green's function is eikonalized. If the external field is chosen to be a laser field, the approximate eikonal propagator is turned into an exact one: Additional assumptions characterizing the eikonal approximation are automatically satisfied. The methods employed are Schwinger's pre-source-theory functional techniques. (auth)

1425 DECOUPLING OF THE POMERANCHON REGGE TRAJECTORY. Brower, R. C.; Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Phys. Lett.; 41B: No. 5, 631-4(30 Oct 1972).

Recently it has been shown that an isolated Pomeranchon Regge pole with unit intercept decouples from many processes at zero momentum transfer. Here it is shown that the vanishing of the Pomeranchon−Reggeon−particle vertex implies the decoupling of the Pomeranchon from total cross sections. The nontrivial Toller angle and signature properties are essential to the argument. This inconsistency with constant cross sections raises serious questions about the physical significance of such a Pomeranchon. (auth)

1426 INTEGRAL EQUATION FOR THE TRIPLE REGGE VERTEX. Pinsky, S. (Univ. of Utah, Salt Lake City). Phys. Lett.; 41B: No. 5, 623-5(30 Oct 1972).

It is shown that, within the context of the multi-Regge integral equation, the triple Regge vertex is the eigenfunction of the multi-Regge kernel, and therefore satisfies an eigenvalue integral equations; the equation is continued to the non-forward case. The zeroes of the triple pomeron vertex are also studied. (auth)

1427 LEPTON–HADRON INTERACTIONS AND QUANTUM ELECTRODYNAMICS. Wilson, R. (Electron Accelerator, Cambridge, Mass.). pp 219-61 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review is given of the status of quantum electrodynamics, elastic lepton−hadron scattering leading to excited nucleon states, lepton−hadron scattering with high excitation energies, and the interaction of time-like photons in colliding beam experiments. (J.F.P.)

1428 GENERAL PROBLEMS OF FIELD THEORY. Hepp, K. (Eidgenoessische Technische Hochschule, Zurich). pp 594-608 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

Recent results are reviewed for perturbation theory and axiomatic and constructure quantum field theory. (J.F.P.)

1429 NON-LINEAR INTERACTION LAGRANGIANS. Efimov, G. V. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 609-27 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review is given of some methods in quantum field theory with essentially nonlinear interaction Lagrangians in the one-component scalar field theory. The second order of perturbation theory is mainly considered, and strict mathematical detail is not given. (J.F.P.)

1430 PROGRESS IN QUANTUM FIELD THEORY. Jaffe, A. M. (Harvard Univ., Cambridge, Mass.). pp 628-32 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.; International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

Field theory models are constructed that satisfy the usual requirements of relativistic local theory and having nontrivial scattering matrices in perturbation theory. The major input is the detailed quantitative properties associated with specific, interaction Lagrangians. Many detailed properties of superrenormalizable field theories are established. The presence of infinite counter terms does not prevent one from giving a mathematically precise formulation of operator field theory without cutoffs. Thus it is found that Lorentz covariance and local commutativity are compatible with the presence of interactions. (J.F.P.)

Gravitation and General Relativity

Refer also to abstract 1032.

1431 WHY IS GRAVITATION FASCINATING? Thirring, W. (CERN, Geneva). pp 230-79 of Elementary Processes at High Energy, Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Gravitation is first discussed in connection with elementary particle physics. The two features of the gravitational interaction that distinguish it from other interactions are discussed—extreme weakness and great universality. The remaining topics deal with gravitational collapse, gravitational radiation, strong universality, and the equivalence principle. (L.B.S.)

1432 TRIP BEHIND THE SCHWARZSCHILD RADIUS. Thirring, W. (CERN, Geneva). pp 280-7 of Elementary Processes at High Energy. Part A. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Some of the general questions of paradoxes which seem to appear in general relativity are discussed. (L.B.S.)

1433 NONMETRICAL SPECIFICATION OF SPACE-TIME SOURCES. Pereira, C. Martin (Univ. of Maryland, College Park). J. Math. Phys.; 13: No. 10, 1542-51(Oct 1972).

The role played by the energy-momentum conservation law in general relativity is examined. It is noted that this law can be interpreted in two ways. It may be thought of as a condition determining the evolution of the energy-momentum tensor density in time, or it may be thought of as a condition determining the metric. The second of these ways of thinking about the energy-momentum conservation law is explored. Einstein's nonvacuum gravitational field equations (which imply the conservation law) are examined. It is shown that given any analytic symmetric contravariant energy-momentum tensor density as a function of the space–time coordinates, a solution to the gravitational field always exists. Furthermore, this solution is such that the law of conservation of energy–momentum is satisfied. The proof uses a coordinate transformation method to exploit the covariance of the energy–momentum conservation law. Riquier's existence theorem enters as an important part of the proof, and a general discussion of Riquier's existence theorem from a physical point of view is given. Both the geodesic nature of the trajectories of free particles and the unit magnitude of the velocity 4-vector are discussed. An interpretation of the above-described results is given. (auth)

1434 STATIONARY AXIALLY SYMMETRIC FIELDS AND THE KERR METRIC. Misra, R. M.; Pandey, Deo Bhushan (Univ. of Gorakhpur, India). J. Math. Phys.; 13: No. 10, 1538-40 (Oct 1972).

The axially symmetric metric for stationary gravitational field, in a slightly general form, is discussed. The vacuum field equations for this metric are given. Specialization of this metric leads to a different form of field equations previously discussed. In particular, the Kerr metric is given in a new form. A justification for interpreting the Kerr metric as an exterior solution corresponding to a spinning rod or a rotating spherical body is given. (auth)

1435 SYMMETRY IN EINSTEIN–MAXWELL SPACE–TIME. Debney, George (Virginia Polytechnic Inst. and State Univ., Blacksburg). J. Math. Phys.; 13: No. 10, 1469-77(Oct 1972).

By using the complex null tetrad as a basis for the tangent space, a Killing vector field ("symmetry") is introduced into the system of Einstein's equations with Maxwell's equations. The two bivectors $F_{\mu\nu}$ and $K_{\mu;\nu}$ (the associated Killing bevector) are assumed to have a principal null direction in common. Killing's equations, Maxwell's equations, and Einstein's equations are then written down for the case where this special direction is also a principal null geodesic for the Weyl conformal tensor. A certain analog of the Goldberg–Sachs theorem is proved. The static cases, plus a sizeable class of the static algebraically special cases are examined, to wit: where the special direction is also shear-free. In particular, all such algebraically special spaces must be Petrov Type D as a result of a coupling of the principal null directions for $F_{\mu\nu}$. This algebraically special metric is derived as an example of the static classes and is a static generalization of the Reissner–Nordström metric. (auth)

1436 SOLAR NEUTRINO AND DILATON THEORY OF NON-NEWTONIAN GRAVITY. Fujimoto, Masa-katsu; Sugimoto, Daiichiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 705-7(Aug 1972).

In the theory of non-Newtonian gravity on the basis of dilaton-graviton coupling the gravitational constant determined by the Cavendish-type experiment should be different from G_∞ for large distances. The effect of this change in the gravitational constant on the solar model and the solar neutrino is discussed. (J.F.P.)

1437 STATIC COSMOLOGICAL SOLUTIONS OF GENERALIZED FIELD EQUATIONS. Tupper, B. O. J. (Univ. of New Brunswick, Fredericton). Progr. Theor. Phys. (Kyoto); 48: No. 2, 678-84(Aug 1972).

The generalized field equations of general relativity derived previously are used to find static Robertson–Walker models. It is shown that in the context of these field equations the negative curvature model has physically acceptable properties. (auth)

1438 GRAVITATIONAL FIELD IN THE UNIFIED SPINOR FIELD THEORY. Katayama, Yasuhisa; Kokubo, Hiroshi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 662-77(Aug 1972).

The possible existence of the gravitational field within the framework of the unified spinor field theory is examined. Though the nonlinear term in the theory might be mainly responsible for hadronic processes, it could also be a source for the realization of the gravitational field as well as the electromagnetic field. A conjecture is made for the introduction of the neutrino with nonzero mass as a clue to the gravitational field just as the charged lepton is to the electromagnetic field. A series of crossed ladder diagrams is taken for the scattering amplitude between baryons to have a coupling constant given by the residue of a spin 2 pole with zero mass. An estimate with a special approximation gives $GM^2 \gtrsim 2\pi(\nu/M)^6$ for the empirical value $5.9 \cdot 10^{-39}$, where M and ν denote the baryon and the neutrino mass respectively. The result gives $GM^2 \gtrsim 0.6 \cdot 10^{-39}$ near the upper bound of the empirical mass of the beta-neutrino, 200 eV. The existence of a scalar gravitational field with small mass is not allowed in the considerations. (auth)

1439 SCALAR–TENSOR THEORY AND GENERAL RELATIVITY. Harrison, E. R. (Univ. of Massachusetts, Amherst). Phys. Rev., D; 6: No. 8, 2077-9(15 Oct 1972).

The various versions of the scalar-tensor theory (e.g., the theories of Jordan, Hoyle, and Brans–Dicke) are derived from a general variational principle. It is shown that scalar-conformal transformations not only interconvert the various current versions of the scalar-tensor theory (i.e., Brans–Dicke theory ≠ Hoyle steady-state theory), but also convert the scalar-tensor variational principle into the variational principle of general relativity. The scalar-tensor formalism is therefore implicitly embodied in the theory of general relativity, thus illustrating the considerable freedom available in specifying the nature and physical content of the "matter tensor" in the Einstein equation. (auth)

Scattering Theory

Refer also to abstracts 1295, 1325, 1383, 1384, and 1402.

1440 EIKONAL APPROXIMATIONS IN COLLISION THEORY. Abarbanel, Henry D. I. (Princeton Univ., N. J.). Contract AT(30-1)-4159. Lect. Theor. Phys.; 14A: 3-46(1972).

The eikonal approximation scheme is discussed, which is very useful in very high energy scattering processes or propagation of waves through a medium. The basic ideas are first discussed in the context of wave propagation in a medium and then the properties of such an approximation scheme within potential scattering is explored. Finally the expression of the eikonal method in quantum electrodynamics is presented. (L.B.S.)

1441 EIKONAL DESCRIPTION OF HIGH-ENERGY PARTICLE SCATTERING. Islam, M. M. (Univ. of Connecticut, Storrs). Lect. Theor. Phys.; 14A: 101-54(1972).

Some aspects of the eikonal description of high energy scattering are discussed under the following headings: eikonal amplitude from field theory; Regge-eikonal model; and optical potential in S-matrix theory. (L.B.S.)

1442 DUAL LOOPS AND MULTIPLY PERIODIC FUNCTIONS. Fenster, Stanley (Argonne National Lab., Ill.). Lect. Theor. Phys.; 14A: 297-335(1972).

It is pointed out that the implementation of unitarity in the factorized dual resonance model requires the addition of dual loops to dual trees. The expression for a single dual loop contains a doubly periodic function and the general theory of M loops brings in multiply-periodic functions of a complex variable. These functions are connected with automorphic functions for Schottky and Fuchian groups. The domains of the complex plane and the harmonic functions defined on them are first treated. Automorphic functions in the dual resonance model are then treated. (L.B.S.)

1443 ANALYTIC EXTRAPOLATION OF SCATTERING AMPLITUDES AND FORM FACTORS. Pfister, H. (Univ., Tubingen, Ger.). Lect. Theor. Phys.; 14A: 455-69(1972).

General considerations on extrapolations are presented, followed by historical remarks on analytic extrapolation. It is pointed out that the analytic extrapolation of physical amplitudes is to a large extent a problem of measure theory in a function space, and results derived with some special conformal transformation depend in a nearly uncontrollable way on this special transformation. The mean value property and the statistical nature of analytic extrapolation are discussed. A brief survey of physical applications is given. (L.B.S.)

1444 TIME DELAY MEASUREMENTS AND THE OBSERVABILITY OF THE COLLISION MATRIX. Goldrich, Fredric E. Princeton, N. J.; Princeton Univ. (1972). 82p. University Microfilms Order No. 72-24,677.

Thesis.

Determination of the phases of the S-matrix elements by means of time-delay measurements is investigated. An analysis of such measurements is presented for spinless, uncharged particles, taking care to insure measurability in the strictest quantum-mechanical sense. A simple case involving particle spins is also analyzed. The result is that one can measure all of the phases except for one undetermined energy- and angle-independent phase for each off-diagonal S-matrix element. By invoking unitarity and time-reversal invariance, additional information can be obtained. (Diss. Abstr. Int., B)

1445 CONNECTION BETWEEN LEVINSON'S THEOREM AND SINGULAR INTEGRAL EQUATIONS. Becchi, C. M.; Collina, R. (Univ., Genoa). J. Math. Phys.; 13: No. 10, 1499-1502 (Oct 1972).

Levinson's theorem is deduced from a general property of singular integral equations in the case in which both the unperturbed and the total Hamiltonian have a finite number of discrete eigenvalues. Also the conditions of validity of the theorem are discussed. (auth)

1446 SCATTERING OF THREE IMPENETRABLE PARTICLES IN ONE DIMENSION. McGuire, J. B. (Florida Atlantic Univ., Boca Raton); Hurst, C. A. J. Math. Phys.; 13: No. 10, 1595-1607(Oct 1972).

A special one-dimensional quantum mechanical three-body problem with an interaction among the particles is solved exactly. The interaction is introduced in such a way that the particles retain their order along a line, and hence the particles are impenetrable. The assumption of impenetrability is consistent with the existence of bound states in all accessible channels, and the probabilities for direct and exchange scattering of one bound pair and one free particle are calculated both below and above the breakup threshold. Above the breakup threshold, the probabilities for breakup and free particle scattering are also found. The absolute squares of all elements of the scattering matrix are given explicitly, and the scattering matrix is shown to be unitary. (auth)

1447 CONVERGENCE OF THE BORN SERIES FOR ALL ENERGIES. Bushell, P. J. (Univ. of Sussex, Brighton, Eng.). J. Math. Phys.; 13: No. 10, 1540-2(Oct 1972).

Formal solution of the Schrödinger equation for nonrelativistic scattering by a spherically symmetric static potential $-\mu V(r)$ leads to a power series in the real parameter μ for the scattering amplitude (the Born series). It is shown that if $\int_0^\infty r|V(r)|\,dr < \infty$, $\int_0^\infty r^2|V(r)|dr < \infty$ and if $-\mu|V(r)|$ is too weak to support a bound state, then the Born series converges at all energies. The method gives a lower bound for the radius of convergence of the Born series which is exact if $V \geq 0$. (auth)

1448 MULTI-REGGEON VERTEX. II. FACTORIZABILITY. Hori, Shoichi (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 48: No. 2, 607-15(Aug 1972).

It is shown that the expression independently derived by Kosterlitz and Wray, Loh-Ping Yu, and Lovelace for the multi-reggeon vertex cannot be factorized into the product of the propagators and the 3-reggeon vertices, unless the projection operators are properly inserted to get rid of spurious states. Also the operators b, $b^\dagger$ introduced by Lovelace have nothing to do with third-quantization but are merely annihilation and creation operators of the harmonic oscillators referring to the internal reggeons. (auth)

1449 P′ REGGE SINGULARITY. Canal, C. A. Garcia (Univ., La Plata). Progr. Theor. Phys. (Kyoto); 48: No. 2, 687-8(Aug 1972).

The main phenomenological results for the P′ Regge trajectory are critically reviewed, and some arguments are presented showing that this singularity may not be considered on an equal footing with the ordinary Regge trajectories. (J.F.P.)

1450 MESH-POINT INVERSION OF THE BETHE–SALPETER EQUATION IN THE SCATTERING REGION. Smith, J. Denmead (Univ. of Reading, Eng.). Phys. Rev., D; 6: No. 8, 2189-97 (15 Oct 1972).

It is shown how numerical results for the scattering Bethe–Salpeter equation may be obtained by mesh-point inversion of the energy-analytic kernel. For scalar scattering the calculated figures agree closely with those of Schwartz and Zemach. The method was used to carry out a Bethe–Salpeter calculation of $\pi\pi$ scattering using a ρ-exchange potential; a self-consistent resonance in the direct channel was not observed. (auth)

1451 ANALYTICAL PROPERTIES OF THE SCATTERING AMPLITUDE AND ASYMPTOTIC THEOREMS. Nguyen van Hieu (Inst. of Physics, Hanoi, Viet-Nam). pp 564-93 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A review is given for the asymptotic behavior of the scattering amplitude and the form factor. The short range of strong interactions as a consequence of the analyticity in the momentum transfer and bounds on the cross section behavior, asymptotic theorems, experimental test of dispersion relations, exact sum rules, and the behavior of the form factor and bounds on the radii of elementary particles are considered. (J.F.P.)

1452 LORENTZ PROPERTIES OF AMPLITUDES. Smorodinskii, Ya. A. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 654-7 of High Energy Physics. /Shelest, V. (ed.). Portland, Oreg.: International Scholarly Book Services, Inc. (1972).

From 15th international conference on high energy physics; Kiev, USSR (26 Aug 1970). See CONF-700806.

A brief summary of Lorentz properties of scattering amplitudes is presented including parametrization of the four-point amplitude, expansion, crossing, unequal masses, convergence, spins, and matrix elements of the Lorentz group. (J.F.P.)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

1453 (BNL-17099) SPIN DIFFUSION OF DILUTE ^{3}He-^{4}He SOLUTIONS UNDER PRESSURE. Cheng, D. K.; Craig, P. P.; Kitchens, T. A. (Brookhaven National Lab., Upton, N. Y.). Jul 1972. 13p. (CONF-720833-17). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

The transport properties of dilute solutions of ^{3}He in ^{4}He provide information about the effective interaction between the ^{3}He quasiparticles. Of the transport properties the spin diffusion coefficient, which can be measured by NMR spin-echo techniques, is most sensitive to these interactions. Such measurements are reported here on 4.97% and 1.15% ^{3}He in ^{4}He for pressures of 0.04, 9.2, and 20 atmospheres at temperatures between 1.5 and 0.072°K. The effective interaction potentials at the three pressures deduced from these data are presented. From these potentials it appears that the temperature of the expected superfluid transition is highest for the lowest pressure and the smaller concentration studied. (auth)

1454 (FRNC-CONF-48) PHYSICAL PROPERTIES OF HELIUM. Laheurte, J. P. (Centre National de la Recherche Scientifique, Grenoble (France)). 1972. 4p. (In French). (CONF-720648-19). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The physical properties of liquid helium 4, the characteristics of helium I and II (superfluid) and the Fontaine effect are described. These properties are interpreted theoretically using the Tisza model and their effect on the use of helium as a cryogenic fluid is discussed. (auth) (France)

1455 (KFKI-72-53) THEORY OF THE TEMPERATURE DEPENDENCE OF THE ROTON ENERGY. Tuetto, I. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Aug 1972. 36p. Dep. NTIS (U. S. Sales Only).

The temperature dependence of the roton energy is examined, considering its collision with any other thermally excited roton and the interaction between one excitation and two rotons. The final-state interaction strongly modifies the two-roton density of states and, therefore, the Hartree-Fock approximation is not valid for the roton-roton scattering. Using a point-interaction model for the roton-roton coupling, and examining only the self-energy processes for the one-particle Green function linear in the number of rotons, it is shown that the amplitude of this temperature dependence changes sign as the roton-roton coupling strength is increased and an upper limit is obtained for the temperature dependence of the roton energy. As this upper limit is only 1/7 of the experimental result, they can be interpreted only by assuming more than seven independent channels with different angular dependences. (auth)

1456 (NP-19473) POTENTIAL BARRIER FOR NEUTRAL EXCITATIONS AT THE LIQUID HELIUM SURFACE. Internal Note No. 375. Calvani, P.; Maraviglia, B. (Rome Univ. (Italy). Istituto di Fisica). 12 May 1972. 15p. Dep. NTIS (U. S. Sales Only).

Neutral excitations (NE) are produced in liquid He II by bombarding with α or β particles. The NEs are excited metastable states of the atom, 2^3S, and the He_2 molecule, $a^3\Sigma_u^+$. The potential barrier at the liquid/vapor interface, which can partially prevent the evaporation of NEs from the liquid, is calculated to be 14.5°K for the 2^3S NE. An experiment was conducted which detected positive and negative ions from the NE-NE annihilation in the vapor. (D.L.C.)

1457 THERMODYNAMIC EVIDENCE AGAINST A QUADRATIC TERM IN THE PHONON SPECTRUM OF SUPERFLUID HELIUM. Zasada, C.; Pathria, R. K. (Univ. of Waterloo, Ont.). Phys. Rev. Lett.; 29: No. 15, 988-91(9 Oct 1972).

A quadratic term, characterized by the coefficient α_1, in the phonon spectrum $\epsilon(k) = \hbar ck(1 - \alpha_1 k - \alpha_2 k^2 - \ldots)$ is shown to be inconsistent with data on the low-temperature specific heat of liquid He II. Consistency obtains if α_1 is set identically equal to zero. (auth)

1458 PHASE DIAGRAM OF A CHARGED BOSE GAS. Hansen, J. P.; Jancovici, B.; Schiff, Daniel (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Rev. Lett.; 29: No. 15, 991-4(9 Oct 1972).

The phase diagram of a charged Bose gas is drawn. The domains of existence of the solid, fluid, and superfluid phases are discussed. It is predicted that superdense helium can be superfluid at densities higher than 10^6 g/cm^3. (auth)

1459 THEORY OF THE ELEMENTARY EXCITATION SPECTRUM OF SUPERFLUID HELIUM: THE ROTON LIFETIME. Solana Madariaga, Javier. Charlottesville, Va.; Univ. of Virginia (1972). 102p. University Microfilms Order No. 72-23,447.

Thesis.

Using the idea of two roton bound states introduced by Ruvalds and Zawadowski the two-roton density of states is studied in detail for all momenta. This, in turn, is used to calculate the single roton lifetime which is compared with available experimental values. A review of the previous studies of the elementary excitation spectrum of superfluid liquid helium is presented. The results of Raman scattering experiments from liquid helium are briefly discussed along with the previous theories advanced to explain them. The theory of two roton bound states is developed in detail. The theory developed is used to calculate the roton lifetime and the width of the two roton bound state at zero momentum which is observed in Raman scattering experiments. (TSS) (Diss. Abstr. Int., B)

1460 HYPERSONIC ATTENUATION IN THE VICINITY OF THE SUPERFLUID TRANSITION OF LIQUID HELIUM. Commins, Daniel Edwin. Los Angeles; Univ. of California (1972). 92p. University Microfilms Order No. 72-25,765.

Thesis.

The attenuation of first sound waves was measured in liquid helium at a frequency of 1 GHz. Absolute measurements were performed with a variable path interferometer for temperatures extending from 1.1°K to 4.2°K. The results confirm those obtained earlier by the same method and those obtained from the Brillouin spectrum of scattered light. They can be described in terms of three regions: a) the normal fluid region above 2.3°K where the attenuation is attributed to the classical losses associated with viscosity and thermal conduction; b) the critical region between 2.0°K and 2.3°K, where the attenuation has a sharp peak occurring near T_λ; c) the superfluid region where the attenuation shows a broad maximum centered at 1.5°K and which is in agreement with the Khalatnikov-Chernikova theory. When the 1-GHz results are compared with the Brillouin scattering results, which vary in frequency from 556 to 768 MHz, it is found that the attenuation scales as ω^2 over the whole temperature range with the possible exception of the data below 1.5°K and in the immediate vicinity of T_λ. (TSS) (Diss. Abstr. Int., B)

1461 HELIUM FLOW THROUGH A SLIT. Smith, Eric Nelson. Ithaca, N. Y.; Cornell Univ. (1972). 107p. University Microfilms Order No. 72-27,979.

Thesis.

A series of measurements was made on the flow of liquid helium through a narrow channel with a spacing between walls of about 4000 A. Measurements were made as a function of pressure head, temperature difference from the λ transition, and channel size. The critical flow velocity and the superfluid density which determine the volume flow rate were analyzed and compared with both theoretical models and related experimental results. (TSS) (Diss. Abstr. Int., B)

1462 ION MOTION IN SUPERFLUID HELIUM USING SPACE-CHARGE-LIMITED CURRENTS. Sitton, Donald McKinley. Charlottesville, Va.; Univ. of Virginia (1972). 83p. University Microfilms Order No. 72-26,279.

Thesis.

Space-charge-limited currents using an 8-Ci, ^{3}H ion source and space-charge-limited corona discharges triggered by field ionization and emission from fine tungsten points are used for ion motility studies in liquid He II. Measured mobilities agree with previous time-of-flight measurements and show a sharp decrease near T_λ beginning about 2.1°K, which is interpreted in terms of an increasing roton density. Negative ion mobility measurements using field emission points below some field-dependent temperature T_c (~1.4°K) are consistent with Careri's expression for the mobility of singly quantized vortex rings. The electric fields as a function of $1/T_c$ as determined by the data are in agreement with the critical field E_c necessary to maintain a stable ion vortex ring complex. The effects of capture and escape of negative ions using the space-charge-limited techniques with the 8-Ci, ^{3}H source at pressures between the vapor pressure and 20 atm are consistent with Vinen's dimensional theory of turbulent He II and previous experimental results on the escape of negative ions from pressurized, rotating He II. In addition, the first measurements on the vortex annihilation rate were made. (Diss. Abstr. Int., B)

1463 SECOND SOUND IN COUNTERFLOWING NORMAL AND SUPERFLUID HELIUM II. Johnson, Earl Mead. Houston, Tex.; Univ. of Houston (1971). 86p. University Microfilms Order No. 72-23,831.

Thesis.

From ordinary hydrodynamics it is known that an entrainment of sound occurs in a moving fluid. A similar effect is expected to take place in the hydrodynamics of Helium II. A measurement has been made of the change in the time of flight of a second sound pulse as a function of the relative velocity ($v_n - v_s$), where v_n is the normal fluid velocity and v_s is the superfluid velocity. A temperature range of 2.10°K through 1.00°K was covered. A typical time of flight at 1.75°K for a second sound pulse for stationary conditions was 5.8622 ms. The change in the time of flight for a normal fluid velocity of 0.4 cm/sec at 1.75°K was 0.7 μs. Each time of flight for the second sound pulses was measured within ± 0.1 μs. (Diss. Abstr. Int., B)

1464 PERSISTENT CURRENT STATES IN ROTATING SUPERFLUID HELIUM CONTAINED IN SUPERLEAK USING DOPPLER-SHIFTED FOURTH SOUND. Kojima, Haruo Los Angeles; Univ. of California (1972). 171p. University Microfilms Order No. 72-25,796.

Thesis.

Fourth sound techniques were extensively developed into a powerful tool for investigating persistent current states in rotating superfluid helium contained in a superleak. Unique features of these techniques are: (1) persistent superfluid component velocity is directly determined by the Doppler-shifted splitting of a fourth sound resonant mode in an annular cavity; (2) the superfluid component density is determined simultaneously and independently by measuring the velocity of fourth sound; and (3) persistent current states are observed from a rotating frame. The fourth sound techniques allow the observation of persistent current states which are otherwise inaccessible in a stationary measurement. As a consequence it is shown that every phenomenon observed in rotating locked superfluid helium (Bose superfluid) has an analogous counterpart in an irreversible type-II superconductor (Fermi superfluid). On the basis of these studies, various statements are made regarding the nature of superfluid helium persistent current states. (TSS) (Diss. Abstr. Int., B)

Superconductivity

1465 (JUL-854-FF) MAGNETIC PROPERTIES OF TYPE II SUPERCONDUCTORS WITH SMALL GINZBURG–LANDAU PARAMETER κ. Auer, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). May 1972. 58p. (In German). Dep. NTIS (U.S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Experimentally studied were the transition from type-I to type-II superconduction as well as the magnetic behavior of type-II superconductors near H_{c1}. Magnetizing measurements were performed at various temperatures and on a large number of samples with Ginzburg–Landau parameters κ from 0.35 to 1.53 for the system Ta + N and 0.78 to 1.0 for the system Nb + N, respectively. The samples showed an almost ideal reversible behavior and, thus, permitted an exact determination of the desired parameters. The temperature dependence of κ were consistently higher than theoretical predictions. For pure tantalum, κ_0 was extrapolated as 0.355. (H.B.G.)

1466 EFFECT OF AN ELECTROMAGNETIC FIELD ON POINT JOSEPHSON JUNCTIONS UNDER STRONG FLUCTUATION CONDITIONS. Dmitrenko, I. M.; Karamushko, V. I.; Snigireva, L. K. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 63: No. 3, 981-4(Sep 1972). (In Russian).

The interaction between a point Josephson junction and an uhf field is studied experimentally for junction resistances and temperatures such that fluctuations suppress not only the current at zero junction voltage but also the current steps on the volt–ampere characteristic induced by external radiation. Under these conditions the current in excess of the normal current and nonlinearity of the volt–ampere characteristic vary periodically with increase of uhf power. The dependence of the oscillation amplitude and period on temperature and radiation frequency correspond qualitatively to the theoretical calculations. (auth)

1467 INVESTIGATION OF TUNNEL CHARACTERISTICS OF SPUTTERED SUPERCONDUCTING Nb_3Sn FILMS. Vedeneev, S. I.; Golovashkin, A. I.; Levchenko, I. S.; Motulevich, G. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 1010-19(Sep 1972). (In Russian).

The tunnel characteristics of sputtered superconducting Nb_3Sn films with T_c = 18.0 to 18.3°K and thicknesses of 0.3 to 2.0 μ are investigated. The I–V characteristics and dependences of dI/dV on V are obtained for Nb_3Sn/Pb and Nb_3Sn/Sn tunnel junctions. The oxide layer on the surface of electropolished Nb_3Sn films and an aluminum oxide layer were employed as tunnel barriers. It is shown that the Nb_3Sn energy gap is much smaller than that predicted by the theory and the tunnel density of states has a complex structure. An anomalously small energy gap $2\Delta/e$ = 0.36 mV is observed for Nb_3Sn. The results are discussed from the viewpoint of anisotropy of the energy gap in Nb_3Sn. (auth)

1468 SUPERCONDUCTOR-EXCITON DIELECTRIC PHASE TRANSITION IN A SEMIMETAL. Aronov, A. G.; Sonin, E. B. (Inst. of Semiconductors, Leningrad). Zh. Eksp. Teor. Fiz.; 63: No. 3, 1059-66(Sep 1972). (In Russian).

The superconducting and dielectric state of a semimetal is considered by taking into account polarization of the lattice. A result of lattice polarization is that the exciton gap for large overlapping may be determined by the longitudinal optical phonon frequency and may be of the same order of magnitude as the superconducting gap. For different effective masses in the conductivity band and valency band, variation of the pressure and the change in overlapping involved may lead to a superconductor–exciton dielectric phase transition. An impurity semimetal in which exciton pairing and Cooper pairing of excess electrons (holes) may occur simultaneously is also considered. Two superconducting states are shown to exist that possess different concentration dependences of the gaps. A phase transition of the first kind may be possible between these states. (auth)

1469 TWO-ZONE CHARACTER OF LONGITUDINAL ULTRASOUND ABSORPTION IN SUPERCONDUCTING NIOBIUM. Druinskii, E. I.; Fal'ko, I. I. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 7, 1216-18(Jul 1972). (In Russian).

A theoretical analysis was made of accumulated experimental data on the absorption of ultrasound longitudinally in superconducting Nb on the basis of the multi-band character of a Fermi surface. Good agreement of the theoretical results with the experimental data was obtained. (K.S.W.)

1470 BOUND STATES DUE TO RESONANCE SCATTERING IN SUPERCONDUCTOR. Machida, Kazushige; Shibata, Fumiaki (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 6, 1817-23(Jun 1972).

It is shown exactly that the bound state in the energy gap of superconductors is produced by the resonance scattering due to a single nonmagnetic impurity. In an appropriate renormalization procedure, the growth of an impurity band is shown in the case of impurities of finite concentration, and a possibility for gapless superconductivity is indicated. (auth)

1471 CURRENT DISTRIBUTION IN A SHIELDED SUPERCONDUCTING FILM. Muchowski, Eugen (Univ., Karlsruhe, Ger.); Schmid, Albert. Z. Phys.; 255: No. 3, 187-95(1972).

The current distribution is investigated theoretically in a shielded superconducting film, which is a film deposited on an insulating superconducting ground plate. An exact result is obtained in the case of a thin and wide film on the basis of London's equation. (auth)

1472 SUPERCONDUCTIVITY IN THE Nb-RICH Nb–Al ALLOYS. Kammerdiner, L.; Luo, H. L. (Univ. of California, San Diego, La Jolla). J. Appl. Phys.; 43: No. 11, 4728-31(Nov 1972).

Nb-rich Nb–Al alloys were prepared by both sputtering and quenching from the liquid state. Lattice constants and superconducting transition temperatures were measured and compared for as-quenched and as-sputtered samples and also for the same samples after annealing. For the samples with between 75 and 80 at.% Nb, annealing produced nearly single-phased β–W alloys with highest transition temperatures of 18.6°K for quenched samples and 16.6°K for sputtered samples. (auth)

1473 UPPER CRITICAL FIELD OF SUPERCONDUCTING NbN FILMS. Yamashita, Tsutomu (Tohoku Univ., Sendai); Kitahara, Shogo; Onodera, Yutaka; Goto, Yukihiro; Aso, Tadao. J. Appl. Phys.; 43: No. 11, 4749-51(Nov 1972).

NbN films were examined with respect to their electrical and superconducting properties. These films were deposited by the dc reactive-sputtering technique under an argon gas atmosphere combined with nitrogen. Critical magnetic fields were measured using a pulsed magnet. Upper critical magnetic fields ranging from 150 to 290 kOe were observed for these films. (auth)

1474 INFLUENCE OF DISSOLVED HYDROGEN ON THE SUPERCONDUCTING PROPERTIES OF MOLYBDENUM. Bhardwaj, Brahm Dev. Houston, Tex.; Rice Univ. (1972). 101p. University Microfilms Order No. 72-26,392.

Thesis.

The superconducting and mechanical properties of triple electron-beam float-zone refined single crystals of molybdenum were

studied before and after the addition of dissolved hydrogen. A dynamic method was used for the measurement of the electrodynamic properties. Pippard's electrodynamic theory of field penetration was extended to account for the observed dynamics of the phase transition from the superconducting to the normal state. Hydrogen was diffused at 1553 and 1823 K. Due to slow quenching to room temperature only .2 and .3 ppM by weight (9.6 and 14.4 atomic ppM) respectively of hydrogen in molybdenum was retained in solution. The normal-state resistivity (calculated from the S → N transition times using the theory for the field penetration) below the critical temperature T_c (for $H > H_c$) is found to increase on the addition of hydrogen, indicating that the electron mean-free-path decreases due to impurity scattering. The transition temperature, however, is insensitive to the dissolved hydrogen within the error of the temperature measurements. The slope of the critical field versus temperature near the critical temperature $(dH_c/dT)_{T_c}$ increases with dissolved hydrogen and when used with the BCS theory leads to an increase in the electronic specific heat coefficient γ and the electronic density of states at the Fermi surface, N(O). Supercooling increases with annealing, and with the addition of hydrogen, and shows an anomalous behavior near the critical temperature that cannot be explained by existing theories of surface-sheath nucleation and proximity effects. Molybdenum becomes softer when hydrogen is added which, along with the superconducting measurements, leads to the conclusion that hydrogen dissolves in the molybdenum lattice as an interstitial ion and is uniformly distributed in the matrix. Tensile measurements at liquid nitrogen temperature and high strain rate (50.8 mm/min) indicate that the Ultimate Tensile Strength (UTS) increases considerably when hydrogen is added. At room temperature and low strain rates, however, the yield stress and UTS remain unchanged with the addition of hydrogen, but the load at fracture, which is zero without hydrogen, is very large for samples containing hydrogen. At liquid nitrogen temperature, molybdenum with or without hydrogen fractures in a brittle manner. At room temperature, well annealed single crystals of molybdenum display considerable ductility and neck down to a chisel edge before fracture (~98% reduction in cross-sectional area). With the addition of 1 ppM by weight (48 at. ppM) hydrogen, molybdenum fractures at room temperature in a brittle manner and has considerably less ductility (percent reduction in cross section area on fracture ~46%). The activation volume, a measure of resistance to dislocation movement by interstitial pinning, decreases with plastic strain and is not affected by hydrogen solution. It is pointed out that while dissolved hydrogen causes marginal changes in the fundamental physical properties of molybdenum, it plays an important role in the fracture properties. (Diss. Abstr. Int., B)

1475 THERMAL CONDUCTIVITY OF THE KONDO SUPERCONDUCTOR Zn–Mn. Sanchez, Daniel Horacio. New Brunswick, N. J.; Rutgers–The State Univ. (1972). 102p. University Microfilms Order No. 72-27,591.

Thesis.

The thermal conductivity in bulk samples of pure Zn and the Kondo alloy Zn–Mn were measured in the temperature range .360 to about 1.0°K for the concentrations 2.7, 6.0, 8.4, 10.0 and 11.7 parts per million (ppM) Mn. The results for the depression of the superconducting to normal state transition temperature (T_c) with Mn concentrations and for the temperature dependence of the thermal conductivities of pure Zn agree with the results obtained by other workers. The ratios of the thermal conductances in the superconducting to normal states have been quantitatively compared with the Bardeen, Rickayzen and Tewordt, and Ambegaokar and Griffin theories. Agreement was found between the Ambegaokar and Griffin theory and experiment at all temperatures for Mn concentrations lower than 10.0 ppM and discrepancy between theory and experiment in the 10.0-ppM and 11.7-ppM samples. In the latter specimens the measured conductance ratios were greater than the theoretical predictions. T_c for these two samples occurs at about the temperature where ordering (impurity–impurity interactions) is observed in the normal state. Measurements were analyzed using those solutions of the Kondo problem in superconductors dealing mainly with the existence of bound states in the energy gap and, also, available theories on the effects of impurity–impurity interactions. It was concluded that the results can be qualitatively understood using the ideas of Fowler and Maki II and Zittartz and Mueller–Hartmann which give a bound state in the energy gap. It appears that the growth of the band and impurity–impurity interactions (spin ordering) are intrinsically related. (Diss. Abstr. Int., B)

1476 CHANGE IN THE SUPERCONDUCTING TRANSITION TEMPERATURE OF DEFORMED NIOBIUM STANNIDE. Vereshchagin, L. F.; Konyaev, Yu. S.; Berzon, E. M.; Veller, M. V. (Inst. of Physics of High Pressures, Moscow). Dokl. Akad. Nauk SSSR; 203: No. 6, 1270-1(1972). (In Russian).

Rods of Nb–36% Sn alloy 1.5 to 3 mm in diameter, and consisting chiefly of Nb_3Sn, were subjected to plastic deformation. The superconducting transition temperature T_c was then investigated as a function of the extent of deformation. A sharp drop in the T_c value resulted from deformation in excess of 20 to 30%, but was accompanied by increased spread between the initial and final transition temperatures. (K.S.W.)

1477 MAGNETIC PROPERTIES OF VANADIUM AND NIOBIUM AT T = 0°K. Leplae, L.; Mancini, F.; Umezawa, H. (Univ. of Wisconsin, Milwaukee). Phys. Rev. B; 6: No. 11, 4178-84 (1 Dec 1972).

The boson method in superconductivity is applied to the study of the mixed state of pure vanadium and niobium at zero temperature. The magnetization curves around H_{c1} are presented and are in good agreement with experimental data. The results depend on the constant $\alpha = \frac{1}{18}\pi^2 N(0)V$, which plays an important role in the boson method. Although the transition at H_{c1} is of the second order, the magnetization curve is very similar to what one would expect for a first-order transition. (auth)

1478 FLUCTUATION CONTRIBUTIONS TO THE HEAT CAPACITY OF AMORPHOUS SUPERCONDUCTING FILMS. Zally, G. D.; Mochel, J. M. (Univ. of Illinois, Urbana). Phys. Rev. B; 6: No. 11, 4142-50(1 Dec 1972).

The heat capacities of superconducting amorphous films were measured near the transition temperature. The films, of bismuth–antimony alloy, had an area of 0.5 cm^2 and thickness ranging from 150 to 1350 Å. An ac temperature calorimetric technique was employed. Fluctuation contributions to the heat capacity were observed. Resistivity measurements of the same films displayed the same fluctuation effects reported by other authors. The temperature dependence of the fluctuation heat capacity was consistent with a behavior of (reduced temperature)$^{-1}$ and had the same width as the resistive transition. No singular behavior near T_c was observed. The temperature dependence close to T_c predicted by Masker, Marcelja, and Parks was not seen. The rounding of the transition can be understood by a Hartree-like theory first proposed by Gunther and Gruenberg. (auth)

1479 PROBLEMS IN CONSTRUCTING A PROPER THEORY FOR FLUCTUATION-INDUCED DIAMAGNETISM IN A SUPERCONDUCTOR. Patton, B. R.; Wilkins, J. W. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. B; 6: No. 11, 4349-51(1 Dec 1972).

The basic disagreement between theory and experiment for the susceptibility of a dirty superconductor near the transition temperature lies in the failure to properly treat the high-energy fluctuations. The ad hoc approach of Nam is shown to be unsatisfactory, and the agreement with experiment spurious. (auth)

1480 TUNNELING STUDY OF THE SUPERCONDUCTING PROXIMITY EFFECT IN THE THIN-NORMAL LIMIT. Wyatt, P. W.; Barker, R. C.; Yelon, A. (Yale Univ., New Haven). Phys. Rev. B; 6: No. 11, 4169-78(1 Dec 1972).

The tunneling characteristics of Pb/Zn-oxide/Pb junctions are reported in which the average Zn thickness is approximately one atomic layer. This thin layer is produced either by indirect evaporation of Zn or by dissociation of ZnS upon evaporation. The tunneling characteristics show an added current shoulder just above the gap-edge voltage similar to that frequently reported for Nb junctions and several other systems, but unexplained until recently. The McMillan theory of the proximity effect is discussed in relation to earlier experiments using thicker normal films. The theory is then used to demonstrate that the observed current shoulder results from the proximity effect, involving a much thinner normal layer than in any previous experiments. A similar effect can explain the observations with Nb and other materials. (auth)

1481 MAGNETIC FIELD DEPENDENCE AND Q OF THE JOSEPHSON PLASMA RESONANCE. Pedersen, N. F. (Univ. of Pennsylvania, Philadelphia); Finnegan, T. F.; Langenberg, D. N. Phys. Rev. B; 6: No. 11, 4151-9(1 Dec 1972).

The results of an experimental study of the magnetic field dependence of the Josephson-plasma-resonance frequency and linewidth in Pb/Pb oxide/Pb tunnel juctions are reported. In the presence of an external magnetic field, the plasma mode is found to be sensitive to an antisymmetric component of supercurrent density which is not observed in conventional measurements of the field-dependent critical current. The frequency and field dependence of the plasma-resonance linewidth are interpreted as evidence that the previously unobserved quasi-particle-pair-interference tunnel current predicted by Josephson exists and has the expected magnitude but the opposite sign. (auth)

1482 SUPERCONDUCTIVITY OF NONSUBSTITUTIONAL SOLID SOLUTIONS: Pb(Ag) AND Pb(Au). Ray, R.; Hahn, S. H.;

Giessen, B. C. (Northeastern Univ., Boston). Acta Met.; 20: No. 12, 1335-7(Dec 1972).

Metastable thin films consisting of Pb(Ag) and Pb(Au) solid solutions with up to 12 at. % solute were prepared by very rapid quenching from the melt (splat cooling). These solid solutions are not of the common, single-substitution type. The variation of the superconducting transition temperature T_c with composition x was determined. A linear decrease of T_c with x was observed. By comparing the valence effects of T_c in Pb(Ag) and Pb(Au) with those in other stable Pb solid solutions, an interstitial model was ruled out. The data support a di-substitutional model in which two solute atoms substitute for one solvent atom. (auth)

1483 EXPERIMENTAL EVIDENCE FOR SURFACE PINNING BY DEFECTS IN SUPERCONDUCTING NIOBIUM CRYSTALS. Kramer, E. J.; Gupta, A. D. (Cornell Univ., Ithaca, N. Y.). Phil. Mag.; 26: No. 4, 779-800(Oct 1972).

The extrapolated critical current density J_F is observed to increase strongly as the angle ϕ between the magnetic field ($H < H_{c2}$) and a flat surface of a niobium crystal prism is decreased. The data can be represented by the empirical equations $J_{Fo} = J_B + a/|\sin(\phi - \zeta + \gamma)|$, and $J_{Fi} = J_B + a/|\sin(\phi - \zeta - \gamma)|$, where J_{Fo} and J_{Fi} are critical current densities when the Lorentz force on flux lines is out of, and into, the surface respectively. The equation for J_{Fo} holds for all values ϕ, but that for J_{Fi} holds only for ϕ greater than some critical value. A 1% tensile deformation increases a by at least an order of magnitude for $H < 2.0$ kOe; for each face of the prism the increase in a is proportional to the number of dislocations threading that face. Annealing decreases a; ageing the prism in air at room temperature increases a. These results demonstrate that pinning by crystal defects near the surface is the principal factor in determining the surface contribution to the critical current in niobium and imply further that crystal defects near the surface are much more effective pinning centres than the same species of defect in the bulk. Since the increase in a, induced by plastic deformation, extrapolates to zero at H_{c2}, the enhanced effectiveness of dislocation pins near the surface cannot be attributed to the presence of the surface sheath. Although the surface flux pinning model outlined in the preceding paper can predict many of these results, there are also important discrepancies. (auth)

1484 POSSIBILITY OF OBSERVING FLUXONS BY TRANSMISSION ELECTRON MICROSCOPY. Capiluppi, C.; Pozzi, G.; Valdre, U. (Univ., Bologna). Phil. Mag.; 26: No. 4, 865-83 (Oct 1972).

Contrast produced by quantized magnetic flux lines when observed by means of out-of-focus techniques in a transmission electron microscope is calculated for a superconductor satisfying the London equation. The following parameters and geometries were taken into account: specimen thickness, position of the fluxon inside the specimen, number and distribution of fluxons, defocus distance, accelerating voltage, and superconducting penetration depth. It is shown that the contrast is easily observable for a proper choice of the above parameters. However, the effect of inelastic scattering and the requirement of beam coherence may demand the use of special techniques in order to detect the contrast. (auth)

1485 ANOMALOUS DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE T_c OF $CeRu_2$ ON MAGNETIC ION CONCENTRATION. Hillenbrand, B; Wilhelm, M. (Siemens Research Labs., Erlangen, Ger.). Phys. Lett.; 41A: No. 5, 419-20(23 Oct 1972).

Measurements were made on $Ce_{0.84}Y_{0.16-x}Gd_xRu_2$. It is shown that the anomalous concentration dependence of T_c of $CeRu_2$ on gadolinium concentration is not a simple superposition of the pair-breaking effect of magnetic ions and an alloying effect. (auth)

1486 CRITICAL FIELD DEVIATIONS IN SUPERCONDUCTING LEAD–INDIUM ALLOYS. Padamsee, H.; Neighbor, J. E. Shiffman, C. A. (Northeastern Univ., Boston). Phys. Lett.; 41A: No. 5, 427-8(23 Oct 1972).
427-8(23 Oct 197

Deviations of the thermodynamic critical field from the conventional parabolic law in single-phase Pb–In alloys are found to decrease monotonically with increasing indium concentration. This is contrary to the behavior of the usual "coupling strength" parameters, $2\Delta(0)/kT_c$ and T_c/θ_D, in the same alloy system. (auth)

1487 TRANSITION OF 280-GHz PHONONS FROM SUPERCONDUCTING TUNNELING JUNCTIONS INTO LIQUID HELIUM AND SILICON. Trumpp, H. J.; Lassmann, K.; Eisenmenger, W. (Univ., Stuttgart). Phys. Lett.; 41A: No. 5, 431-2(23 Oct 1972).

Comparative phonon-emission experiments carried out in liquid helium and vacuum, with superconducting tin/tin tunneling junctions evaporated on silicon crystals, show a transmission into helium about three times higher than the transmission into silicon. (auth)

1488 $Zr_{3+4}S_4$: A NEW SUPERCONDUCTING BINARY SULFIDE. Johnston, D. C.; Moodenbaugh, A. (Univ. of California, San Diego, La Jolla). Phys. Lett.; 41A: No. 5, 447-8(23 Oct 1972).

Superconductivity was observed in the NaCl defect structure of $Zr_{3+x}S_4$. In one sample, the T_c of 3.3°K at atmospheric pressure, increased to 7.2°K at pressures near 160 kbar. The resistivity shows a negative temperature coefficient at all pressures. (auth)

1489 MICROWAVE PROPERTIES OF SUPERCONDUCTING Pb–In WIRES. Huang, C. Y. (Case Western Reserve Univ., Cleveland); Rachford, F.; Wolf, S. Phys. Lett.; 41A: No. 5, 465-6(23 Oct 1972).

The microwave properties of superconducting Pb–In wires were studied as a function of a magnetic field and temperature at 9.2 GHz. Anomalies in the absorption were found both near the critical field and the critical temperature. (auth)

1490 INTERMEDIATE STATE OF SUPERCONDUCTING NIOBIUM. Essmann, U. (Max-Planck Institut fuer Metallforschung, Stuttgart). Phys. Lett.; 41A: No. 5, 477-8(23 Oct 1972).

A domain pattern characteristic for an attractive interaction between flux lines and a correlation between the flux-line lattice and the crystal lattice of niobium crystals is observed. (auth)

1491 INFLUENCE OF PRESSURE ON PROPERTIES OF SUPERCONDUCTORS WITH PARAMAGNETIC IMPURITIES. Palistrant, M. E. (Moldavian Academy of Sciences, Kishinev). Phys. Lett.; 41A: No. 5, 473-4(23 Oct 1972).

An investigation is made of the influence of Fermi-surface topology changes on the transition temperature and critical impurity concentration of superconductors with paramagnetic impurities. Dependent on the type of topology changes of the Fermi surface in dirty superconductors, the pressure can restore or destroy the superconductivity. (auth)

1492 MODEL OF SURFACE FLUX LINE PINNING IN TYPE II SUPERCONDUCTORS. Kramer, E. J.; Gupta, A. D. (Cornell Univ., Ithaca, N. Y.). Phil. Mag.; 26: No. 4, 769-77(Oct 1972).

The contribution of pins at the surface of the superconductor to the dynamic pinning force density F_p is derived from the hypothesis that the shear constant C_{66} of the flux line lattice is small in a surface layer. (auth)

1493 PROBLEM OF HIGH TEMPERATURE SUPERCONDUCTIVITY. Ginzburg, V. L.; Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). Phys. Rep.; 4C: No. 7, 343-56(1972).

The present situation in theoretical investigations of high-temperature superconductivity is briefly reviewed. The main subject is a discussion of the formula for a critical temperature T_c for a homogeneous and isotropic substance with arbitrary permeability $\epsilon(q,\omega)$. The problem of the maximum possible value of T_c is discussed. It is concluded that at present there are no grounds to consider values of $T_c \gtrsim 100$°K to be impossible. Remarks are made on the exciton mechanism of superconductivity for the case of superconductors with a plane geometry. (25 references) (auth)

1494 FUNCTIONAL INTEGRAL METHOD ON SUPERCONDUCTING CRITICAL PHENOMENA. I. Takayama, Hajime Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 2, 382-406 (Aug 1972).

Superconducting critical phenomena in the whole temperature range, including the region below T_c, are investigated with the aid of the functional integral representation of superconductivity. Particularly in the true critical range, where the mean field theoretical approach for interacting fluctuation modes breaks down, the one-particle Green's function, i.e., the fluctuation propagator, is examined by the dimensional analysis method, and the shift of the transition temperature from that defined by the BCS theory is obtained. Further, an excess conductivity in this range is shown to saturate to the value of the order of the normal-state conductivity irrespective of the dimensionality of specimen, except in the very narrow range near the shifted transition temperature T_c. Characteristic aspects of fluctuations just at and below T_c are also investigated, and, in particular, a mechanism for intrinsic resistivity below T_c due to thermally activated processes of fluctuations is conjectured even in a two-dimensional superconductor. The microscopic justification of the functional integral method, which is just the Ginzburg–Landau theoretical scheme, is also given. (auth)

1495 SUPERCONDUCTING TRANSITION TEMPERATURE, ELECTRIC RESISTANCE, AND OPTICAL ABSORPTION SPECTRA OF Be AND Zn FILMS EVAPORATED TOGETHER ON CERTAIN

DIELECTRICS. Alekseevskii, N. E.; Tsebro, V. I.; Zakosarenko, V. M.; Al'shitz, A. I.; Personov, R. I. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Eng. Transl.); 15: No. 11, 472-5(20 Jun 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 11, 668-73(5 Jun 1972).

Absorption spectra of the following systems were investigated: Be–Zn etioprophyrin (ep), Zn–Zn ep, and Zn–Zn phthalocyanine. The spectral peaks coincide with those of the pure organic films. The superconducting T_c of Zn–Zn ep films exceeded that of pure Zn films, reaching 2.0°K for a metal: Zn ep ratio of 3:1. The resistivity of all films evaporated jointly with Zn ep decreased upon heating. Results favor the hypothesis that the jointly evaporated films constitute a fine dispersion of metallic particles that do not interact with the dielectric. (D.L.C.)

Equipment and Devices

1496 (CEA-CONF-2044) CERTAIN ASPECTS OF REFRIGERATION USING LIQUID HELIUM. Claudet, G.; Verdier, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 6p. (In French). (CONF-720648-14). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The general operating principles of a thermodynamic cycle extracting heat at 4.2°K are briefly described and it is shown that, whatever cooling method is applied at intermediate temperature, a Joule–Thomson cascade must be used for the final stage. This fact is discussed in detail in order to establish the optimum operating and pre-cooling conditions. Practical design aspects of the cascade are considered; a simple process for separating the phases of the mixture obtained by expansion is described; reference is made of two low-temperature radiation equipment cooling installations of this type. (France)

1497 (RPP/E-19) CRYOGENIC HEAT PIPE: A REVIEW OF WORK AT THE RUTHERFORD LABORATORY. Mortimer, A. R. (Rutherford High Energy Lab., Chilton (England)). Aug 1972. 11p. (CONF-720940-1). Dep. NTIS (U. S. Sales Only).

From Chisa '72 conference; Prague, Czechoslovakia (Sep 1972).

Liquid hydrogen heat pipes were developed for operation on liquid hydrogen targets used for nuclear physics research. A description is given of the fluid flow and heat transfer work leading to the successful design, using a woven glass fiber wick. Liquid nitrogen and liquid helium heat pipes were operated satisfactorily. Performance figures are presented. (UK)

1498 JOSEPHSON WEAK LINKS: SHUNTED-JUNCTION AND MECHANICAL-MODEL RESULTS. Hansma, P. K.; Rochlin, G. I. (Univ. of California, Berkeley). J. Appl. Phys.; 43: No. 11, 4721-7(Nov 1972).

Two models of a superconducting weak link were investigated, giving physical insight into the behavior of many Josephson-effect devices. The first of these is a low-inductance oxide-barrier Josephson tunnel junction with an external resistive shunt; the second is a mechanical analog—a driven damped pendulum. The externally shunted junction acts as a generalized weak link in that, by adjusting its shunt resistance or critical supercurrent, it exactly replicates the dc electrical characteristics of many widely different weak links. In fact, its characteristic may be altered readily while the junction is immersed in liquid helium simply by applying a small external magnetic field of 1 Oe or less to decrease the critical current. The mechanical analog, by enabling observation of the instantaneous behavior of the phase, gives new insight into the nonlinear properties of such weak links. The behavior of both models is governed by the second-order nonlinear differential equation independently proposed by Stewart and McCumber. These models not only verify the computer-generated solutions for weak links in detail, they give new physical insight into the underlying nonlinear behavior. (auth)

1499 CONSTANT HOMOGENEOUS MAGNETIC FIELD IN SUPERCONDUCTING SOLENOIDS BY MEANS OF A SCREEN OF A HIGH PARAMETER SUPERCONDUCTOR. Lazarev, B. G.; Lazareva, L. S.; Poltavets, V. A. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 203: No. 4, 810-12(1 Apr 1972). (In Russian).

Requirements of homogeneous fields inside of superconducting laboratory solenoids have resulted in complicated and cumbersome winding designs. A superconducting cylindrical screen of Nb_3Sn is described for insertion into a solenoid of ordinary length and wound of Nb–60 at.% Ti alloy wire. A remarkably homogeneous field resulted within the screen when tested at 5,700 and 50,000 Oe, although the intensity of the field is slightly reduced by its use as compared with the peak intensity of the nonhomogeneous field in the absence of the screen. (K.S.W.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 183, 1816, and 1870.

1500 (AD-738175) SAMCEP: AN APPLICATION OF CORRELATED MONTE CARLO TO THE SIMULTANEOUS SOLUTION OF MULTIPLE, PERTURBED, TIME-DEPENDENT NEUTRON TRANSPORT PROBLEMS IN COMPLEX THREE-DIMENSIONAL GEOMETRY. Final Report, December 1, 1970–December 1, 1971. Hui, Shirley; Spielberg, David; Steinberg, Herbert; Troubetzkoy, Eugene S.; Kalos, Malvin (Mathematical Applications Group, Inc., White Plains, N. Y.). Jan 1972. Contract DAAD05-70-C-0295. 164p. (MR-7020(P-7007); BRL-CR-62). NTIS.

SAMCEP is a system of U.S.A. Standard FORTRAN programs for the solution by Monte Carlo methods of several correlated neutron transport problems in complex three-dimensional geometries. Up to 10 correlated problems, involving up to 100 perturbations, of composition, neutron cross sections, angular or energy distributions, and/or source spectra, can be run simultaneously. Individual problem fluxes or doses (region-, energy-, and (on option) time-dependent), as well as the differences between those of any or all pairs of problems, are available. SAMCEP retains essentially all the features of its predecessor code, SAMCE, including the use of basic neutron data in the latest ENDF/B format. (auth)

1501 (CCDN-NW-12) NEWSLETTER BULLETIN NO. 12. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Oct 1970. 119p. Dep. NTIS (U. S. Sales Only).

This newsletter is a revised version of the list published by CCDN in April 1969 as Newsletter No. 9 and covers in particular the major evaluations first presented at successive international conferences on neutron data. The criteria for inclusion in the list have been that the material should be generally available, that it should give a complete set of data for input to neutronics calculations, and that full documentation should be provided in support of the evaluation. (W.D.M.)

1502 (CCDN-NW-13) NEWSLETTER BULLETIN NO. 13. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). Feb 1972. 360p. Dep. NTIS (U. S. Sales Only).

This newsletter is intended to inform all users of neutron data about the content of the CCDN Experimental Neutron Data Library as of Feb. 1972. It supersedes the last index (CCDN-NW/11) of Oct. 1969. (W.D.M.)

1503 (CCDN-NW-14) NEWSLETTER BULLETIN NO. 14. (ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France)). May 1972. 164p. Dep. NTIS (U. S. Sales Only).

This newsletter replaces the last version of the list of "complete" evaluations (CCDN-NW12). The criteria for completeness was that the evaluations should cover a reasonably wide range of neutron energy for the cross section concerned. (W.D.M.)

1504 (JAERI-Memo-4018) EXPERIMENTAL METHOD FOR MEASUREMENT OF ANISOTROPIC NEUTRON FLUX NEAR RESONANCE ENERGY OF 4.9 eV OF ^{197}Au. Kaneko, Yoshihiko; Kitadate, Kenji (Japan Atomic Energy Research Inst., Tokyo). Apr 1970. (In Japanese). NTIS (U. S. Sales Only).

P_0 and P_1 components of the neutron flux in a light water spectrum source are measured in the energy region around the giant resonance of gold, 4.9 eV, by use of a new foil activation technique. The principle of the new technique is to determine P_0 and P_1 components from the analysis of the activations of a set of thin three gold foils by using a Legendre polynomial expansion of the neutron flux. (auth)

1505 (JAERI-Memo-4078) EFFECTS OF THE SCATTERING MODELS TO THE LATTICE CONSTANTS. Tsuchihashi,K.; Mori, N. (Japan Atomic Energy Research Inst., Tokyo). Jun 1970. (In Japanese). NTIS (U. S. Sales Only).

The available scattering models (effective width model, Nelkin model, ENDF/A file) are applied to typical lattice cells. Effect of the exchange of the available scattering models to the lattice constants is considered. The thermal averaged cross sections and η_f are little influenced by the models, but the ratio of the epithermal component to Maxwellian component depends on the model. If the lowest resonance level of ^{240}Pu is processed in the thermal region the choice of the scattering model must be taken care of. The diffusion parameters of D_2O reduced from the Nelkin model and ENDF/A file differ from the experimental value. The equivalent diffusion coefficients for the D_2O lattice by the above two models differ several percent from the effective width model. (auth)

1506 (JINR-P4-6553) ELASTIC REFLECTION OF ULTRACOLD NEUTRONS FROM THE PLANE COMPLETELY BOUNDING DISORDERED MEDIA. Ignatovich, V. K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Elastic interaction of ultracold neutrons with disordered media, bounded perfectly by the plane surface, is considered. It is shown that noncoherent scattering, resulting from disordered location of nuclei, does not lead to penetration inside the media. Formulas are derived for the absorption coefficient in the case when the surface is contaminated by absorbent. (auth)

1507 (NP-19444) CONSTANT ANISOTROPIC SCATTERING OF NEUTRONS AND TIME-DEPENDENT NEUTRON TRANSPORT. Zebitay'an, Sehsuvar (Cekmece Nuclear Research and Training Center, Istanbul (Turkey)). 1972. 78p. (In Turkish). Dep. NTIS (U. S. Sales Only).

Thesis.

Two specific problems on neutron distributions in multiplying media are studied. Both the problems are discussed in the framework of semi-local models of neutron distributions. The first problem is an attempt to generalize the method of A. Y. Özemre of bringing the time-dependent anisotropic neutron distribution within the framework of the classical and conventional neutron diffusion theory to the cases where the macroscopic scattering cross section Σ_s as well as the neutron flux ϕ would be developed in series exhibiting this anisotropy up to a certain degree of complexity. This method enables one to construct diffusion schemes with growing complexity. The second problem concerns the solution of time dependent neutron transport equation for plane geometry and monoenergetic neutrons, taking into account the contribution of delayed neutrons to the balance in the medium considered. Under some conditions, it is possible to apply to this equation the method of the separation of the variables, thus obtaining three separate equations. Two of them are immediately integrated but in order to solve the third, it is necessary to apply the so-called Case method which consists of finding the eigendistributions of a certain type of equation. This equation has a spectrum with continuous and discrete parts. As the eigendistributions are proved not to form an orthogonal system, one is led to formulate an adjoint problem in such a way that the corresponding adjoint eigendistributions may be orthogonal to the previous ones. The discrete parts of both spectra are found to be identical; some interesting relations between the corresponding continuous eigenvalues of both the spectra are also determined. (auth)

1508 SPACE-TIME KINETICS OF HETEROGENEOUS SYSTEMS USING TWO-GROUP NEUTRON-DIFFUSION THEORY. Arakali, Venkatesha Murthy S. Morgantown, W. Va.; Univ. of West Virginia (1972). 141p. University Microfilms Order No. 72-26,858.

Thesis.

The two-group time-dependent diffusion equations have been formulated for systems where the heterogeneities are represented by delta functions. Proper Green's functions have been derived and used to convert the differential equations into integral equations. The integral equations were solved by expanding the flux in terms of normalized eigenfunctions of a homogeneous system, appropriate to the geometry of the system. The material properties of the heterogeneities and the surrounding medium were assumed to be completely arbitrary so that solution could be applied to various combinations of multiplying systems. Expressions for critical conditions were obtained for slab and cylindrical geometries, and relations for slow and fast fluxes are derived for systems consisting of an arbitrary number of heterogeneities. Numerical examples are given for each geometry, and comparisons are made between this work and exact multi-region diffusion theory. Good agreement is obtained between the present theory and the exact multi-region diffusion theory in all the cases investigated. An infinite slab system consisting of two and four heterogeneities was also considered to demonstrate the ease with which the work presented here can be extended to multi-heterogeneity problems. Time-dependent diffusion equations are solved in slab and cylindrical geometries. Application of the solutions is illustrated by calculating decay constants for the following systems: (1) Medium multiplying heterogeneity non-multiplying. (2) Both medium and heterogeneity multiplying. (3) Both medium and heterogeneity non-multiplying. An effort was made to determine the range of validity of the present theory for a specific case of single non-multiplying heterogeneity imbedded in a non-multiplying medium by varying the macroscopic absorption cross section of the heterogeneity relative to that of

the surrounding medium. Although no conclusion could be drawn from this analysis, it is felt that a number of additional cases need to be considered in order to establish and possibly enhance the validity of the present theory by obtaining a definite expression for w_h which has hitherto been considered as only a geometric factor. (Diss. Abstr. Int., B)

1509 NEUTRON DISPLACEMENT CROSS SECTIONS FOR STAINLESS STEEL AND TANTALUM BASED ON A LINDHARD MODEL. Doran, D. G. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Sci. Eng.; 49: No. 2, 130-44(Oct 1972).

The theory developed by Lindhard and co-workers for the partition of energy as an energetic ion slows down in a solid was applied to the calculation of neutron displacement cross sections for iron, chromium, nickel, stainless steel, and tantalum. ENDF/B data were used to incorporate anisotropic elastic and isotropic inelastic neutron scattering. A contribution from (n,γ) recoils was also included. The results for stainless steel are presented in tabular form for convenience. (12 figures, 4 tables) (auth)

1510 COMMENTS ON VARIATIONAL FLUX SYNTHESIS METHODS FOR MULTIGROUP NEUTRON DIFFUSION THEORY. Nakamura, S. (Ohio State Univ., Columbus). Nucl. Sci. Eng.; 48: No. 3, 371-2(Jul 1972).

An important point of Stacey's [Nucl. Sci. Eng., 47, 449 (1972)] overlapping multichannel synthesis method lies in the use of piecewise continuous functions that vanish at channel interfaces where discontinuity of trial functions might occur. It is pointed out that this idea was published previously [Nakamura, Nucl. Sci. Eng., 39, 278 (1970)] as a variational method of accelerating convergence of interactive solutions for diffusion and transport equations. Differences between the two methods are discussed. (R.W.R.)

1511 EFFECT OF SURFACE ROUGHNESS ON THE TOTAL REFLEXION AND TRANSMISSION OF SLOW NEUTRONS. Steyerl, A. (Technische Univ., Munich). Z. Phys.; 254: No. 2, 169-88 (1972).

The total reflection of subthermal and thermal neutrons from rough surfaces is analyzed in the limits of small and large roughness dimensions as compared to the neutron wave length. The analysis shows that the scattering distribution from a submicroscopically rough surface is determined by the spectrum of the roughness, concentrating near the directions of regular reflection and transmission unless the surface irregularities exhibit a long-range correlation. It is shown that submicroscopic surface roughness and macroscopic waviness are the primary sources of reflection losses in guide tubes for ultracold and thermal neutrons, respectively. The present theory explains experimental values for neutron guide tube transmission. The diffraction due to surface roughness is also investigated for cold and ultracold neutron transmission through slabs whose thickness is comparable to or much larger than the neutron wave length. It is shown theoretically and experimentally that such scattering is significant in the ultracold neutron transmission through materials with large scattering potential. (auth)

1512 NEUTRON-SCATTERING AMPLITUDES OF POTASSIUM, STRONTIUM, AND BARIUM. Cooper, M. J.; Rouse, K. D. (Atomic Energy Research Establishment, Harwell, Eng.). Z. Kristallogr.; 135: No. 3-4, 316-17(Jul 1972).

Measured scattering amplitude ratios for KCl, SrF_2, and BaF_2 were used along with precise scattering amplitudes for Cl and F to calculate neutron scattering amplitudes for K, Sr, and Ba. (J.W.R.)

1513 GENERAL THEORY OF PULSED-NEUTRON EXPERIMENTS IN NONMULTIPLYING PERIODIC ASSEMBLAGES. Van Binnebeek, J. J. (Univ. Libre, Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 58: No. 1, 105-23(1972). (In French).

The introduction of approximate limiting conditions, called asymptotic transport, allows the rigorous transformation of the transport problem in a finite periodic assemblage for the problem of determined transport in an infinite network, the solutions being provided for a macroperiodicity. The use of symmetry properties for the transport problem in an infinite network, as well as the Wigner theorems, allows the transposition in the transport theory of results of solid state physics; from these results, a generalization of the Nelkin formulation, which expresses for homogeneous assemblages the decrease of neutron momentum as a function of geometric classical buckling, is deduced. It appears possible to derive a homogeneous equation describing in an equivalent way the decrease of neutrons and, in a parallel way, to justify rigorously the principles of classical calculation for reactor cells. Finally, it is shown how to solve the problem of transport in an infinite network. (tr-auth)

1514 COLLIMATED VANADIUM BATH SYSTEM FOR THE RELATIVE MEASUREMENT OF keV NEUTRON FLUX. Robertson, J. C.; Ryves, T. B.; Hunt, J. B. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 26: No. 10, 507-15(Oct 1972).

A description is given of a collimated vanadium bath system which was used to measure relative neutron flux in the keV energy region. The variation in the detection efficiency of the system with neutron energy was studied using Monte Carlo methods. In particular the effective "neck" size of the collimator and its position relative to the neutron source were calculated as a function of neutron energy. The results of these calculations are compared with experimental measurements. The system was used to measure the relative 0° yield from the $^7Li(p,n)^7Be$ reaction and the results are compared with measurements of the yield made with a long counter. The development of these detectors is important for the accurate measurement of neutron flux. (auth)

1515 ANALYSIS OF THE DOPPLER EFFECT OF STRUCTURAL MATERIALS. Ishiguro, Yukio (Japan Atomic Energy Research Inst., Tokai). Nucl. Sci. Eng.; 49: No. 2, 228-32(Oct 1972).

An analysis of the Doppler effect of structural materials, of possible importance in fast reactor safety, is described. The shielding factors of the effective capture cross sections are prepared for chromium, iron, and nickel based on the nuclear data of ENDF/B-II. By using these shielding factors, the Doppler experiments for stainless steel and natural iron performed in the JAERI-FCA cores are analyzed by a simple perturbation method. The computed results are in fairly good agreement with the experiment, although they are a little lower. It is suggested that the lower values might be attributed to the missing level of the sharp p- and d-wave resonances above 30 keV or to neglecting the contributions from the unresolved resonances. (3 figures, 3 tables) (auth)

1516 TOTAL NEUTRON CROSS SECTION OF MYLAR AT LOW ENERGIES. Madero, C. C. (Comision Nacional de Energia Atomica, San Carlos de Briloche, Argentina); Kropff, F.; Oliva, A.; Neill, J. M. Nucl. Sci. Eng.; 49: No. 3, 392-3 (Nov 1972).

The total neutron cross section of Mylar was measured in the range 0.007 to 20 eV by the time-of-flight transmission method. (auth)

1517 CHISLENNYE METODY V TEORII PERENOSA NEITRONOV. (Numerical Methods in Neutron Transport Theory). Marchuk, G. I.; Lebedev, V. I. Moscow; Atomizdat (1971). 496p.

Computational methods for solving kinetic equations describing neutron transport are explained. Effective one-group theory is considered in detail with a variety of methods, and a considerable number of problems in this field of mathematics are handled. The physical formulation of problems, the characteristics of accurate solutions to kinetic equations, and remainder and other types of approximations and iterative methods are given. (314 references) (tr-auth)

Nuclear Properties and Reactions, $A \leq 5$

1518 (JINR-P1-6595) STUDY OF ELASTIC p-d-SCATTERING AT PRIMARY PROTON ENERGY OF 5 GeV IN THE REGION OF COULOMB AND NUCLEAR INTERACTION INTERFERENCE. Zlatanov, Z. M.; Khristov, L. G.; Devenski, P. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results are presented on measurements of the differential cross section of the forward elastic p-d scattering at the primary proton energy being 5 GeV. The slope parameter for the diffraction cone and the real part of the elastic p-d scattering amplitude are determined. (auth)

1519 (JINR-P2-6562) SPIN EFFECTS IN THE p-He_4 SCATTERING THEORY. Lykasov, G. I.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spin effects in elastic p-^{4}He scattering at T_p = 600 MeV were studied in the Glauber approximation. It is shown that if the spin structure of the N-N amplitudes is included to the consideration the products of the profile functions in ordinary Glauber's expression for the amplitude F of this process are replaced by symmetrized products of the uncommutative operators. The amplitude F may be written as a function of the scalar N-N amplitudes. The calculations of the differential cross-section indicate that the spin effects give a significant contribution to the differential cross section at large momentum transfers. The inclusion of the spin

dependence of the N–N amplitudes succeeds in describing the experimental data provided the nuclear density distribution with parameters D = 0.858, γ^2 = 0.308, R = 1.2 fm is used. The polarization P_0 and the quantities R cos θ + A sin θ, R sin θ – A cos θ are also calculated. The analysis of this calculation shows that in the large momentum transfer region the polarization effects are sensitive to the form of the nuclear density distribution. (auth)

1520 (ORO–4317-14) VARIATIONAL APPROACH TO BREAKUP CALCULATIONS IN THE AMADO MODEL. Technical Report No. 73-015. Brady, T. J.; Sloan, I. H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug 1972. 4p. (CONF-720819–11). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

In Amado's model of neutron–deuteron scattering the scattering equations reduce after partial-wave analysis to one-dimensional integral equations. A recently proposed variational approach to equations of the Lippmann–Schwinger type is tested, by using the method to solve the one-dimensional integral equation for a case in which the exact solution is already known. (W.D.M.)

1521 POLARIZATION OF ^{3}He PARTICLES ELASTICALLY SCATTERED FROM ^{4}He, ^{9}Be, ^{12}C, AND ^{16}O. McEver, William Stover. Chapel Hill, N. C.; Univ. of North Carolina (1971). 89p. University Microfilms Order No. 72-21,577.

Thesis.

A polarimeter based on the scattering of ^{3}He by ^{4}He at a c.m. angle of 45° has been constructed and its analyzing power calibrated for ^{3}He energies between 11.5 and 13 MeV. The analyzing power was found to be large (0.7) and approximately constant over this energy range. With this polarimeter, polarization angular distributions have been obtained for ^{3}He particles elastically scattered at forward angles from ^{9}Be, ^{12}C, and ^{16}O at a mean energy of 18 MeV and from ^{12}C at 20 MeV. Differential cross sections have also been obtained for the elastic scattering of ^{3}He particles from ^{9}Be and ^{16}O at 18 MeV and from ^{12}C at 21 MeV. The forward angle cross-section data have been analyzed with a standard optical-model potential using a Thomas form for the spin-orbit potential. Spin-orbit well depths greater than 3 MeV are required to reproduce the magnitudes of the measured polarizations. No distinction could be drawn between optical-model parameter sets related by the various ambiguities of the optical model on the basis of comparisons with the polarization data. (Diss. Abstr. Int., B)

1522 SCATTERING OF ^{3}He AND ^{4}He FROM POLARIZED ^{3}He BETWEEN 4 AND 10 MeV. Boykin, W. R.; Baker, S. D.; Hardy, D. M. (Rice Univ., Houston, Tex.). Nucl. Phys.; A195: No. 1, 241-9(1972).

The polarization analyzing power of ^{3}He–^{3}He and ^{3}He–^{4}He elastic scattering is reported for bombarding energies from 4.33 to 9.83 MeV. A phase-shift analysis of existing ^{3}He–^{4}He elastic scattering data is presented with attention to the errors assigned to the phase shifts. In contrast to earlier work at low energies, the p-wave phase shifts may be parameterized by single-level formulas to give reasonable values of the nuclear reaction radius and of the ratio of the reduced width to the Wigner limit. The analyzing power of ^{3}He–^{3}He elastic scattering is consistent with zero at $\theta_{c.m.}$ = 60°. (auth)

1523 LARGE-ANGLE ELASTIC SCATTERING OF DEUTERONS FROM HYDROGEN: T_k = 433, 362, and 291 MeV. Igo, G. (Univ. of California, Los Angeles); Fong, J. C.; Verbeck, S. L.; (and others). Nucl. Phys.; A195: No. 1, 33-56(1972).

The elastic scattering cross section of deuterons on hydrogen, $(d\sigma/d\Omega)_{c.m.}$, is measured in the proton's c.m. angular range θ_p = 115° to 170° at bombarding energies of 433, 362, and 291 MeV. The results at 291 MeV agree with earlier measurements at 140-MeV proton bombarding energy. The differential cross section at 180° obtained by extrapolation of the data to $\theta_p = \pi$ decreases rapidly with increasing energy as predicted by a nucleon-exchange mechanism. Further evidence that nucleon-exchange dominates is found in the behavior of $(d\sigma/d\Omega)_{c.m.}$ at large angles. In this energy range, as well as at higher bombarding energies (equivalent to 632 MeV deuterons), $(d\sigma/d\Omega_{c.m.}$ is universally dependent on the momentum-transfer variable of the nucleon-exchange mechanism [$\Delta = (\frac{3}{4}\cos\Theta_p + \frac{1}{2}t_f)^{\frac{1}{2}}$] ($t_f$ is the four-momentum transfer squared for elastic scattering). The purpose of the experiment has been to determine the D-state probability P_D through the medium of the neutron-exchange mechanism. Preliminary calculations not reported here suggest that the differential cross section between 1 and 2 fm^{-1} is quite sensitive to P_D. (auth)

1524 DIFFERENTIAL POLARIZATION OF PHOTONEUTRONS FROM DEUTERIUM. Nath, R.; Firk, F. W. K.; Schultz, H. L. (Yale Univ., New Haven). Nucl. Phys.; A194: No. 1, 49-63(1972).

The differential polarization of photoneutrons from deuterium has been measured at lab reaction angles of 45° and 90° for incident unpolarized photons in the energy range 7 to 30 MeV. The polarization is measured by observing the left-right asymmetry in the elastic scattering of neutrons from a liquid-helium polarimeter which is used in conjunction with a nanosecond time-of-flight spectrometer. At the lowest energies, the ^{12}C (n,n)^{12}C reaction is used as an analyzer. The left-right asymmetry is determined by using the spin-precession method, recently developed for use with a continuous energy spectrum of neutrons. Two independent difference experiments are carried out using C^2H_2–CH_2 and ^2H_2O–H_2O targets in order to detect possible target-dependent systematic errors. Departures from the predictions of current theories of the photo-disintegration of the deuteron are observed at both reaction angles. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 364, 1521, 1635, and 1909.

1525 (COO–3274-1) NUCLEAR MOMENTS AND NUCLEAR STRUCTURE. Annual Progress Report, October 1, 1971–September 30, 1972. Owen, George E.; Madansky, Leon (Johns Hopkins Univ., Baltimore, Md.). 1972. Contract AT(11-1)-3274. 139p. Dep. NTIS.

BORON-12 — nuclear quadrupole moment relative to boron-13, (E)
BORON-13 — nuclear quadrupole moment relative to boron-12, (E)
CADMIUM-110 — energy-level scheme from zirconium-96 (O-16,4n) reactions, (E)
ERBIUM-167 — proton inelastic scattering at 4 MeV with Coulomb excitation, Moessbauer study of temperature spikes following, (E)
— alpha inelastic scattering at 10 MeV with Coulomb excitation, Moessbauer study of temperature spikes following, (E)
FLUORINE-20 — energy levels from fluorine-19 (α,p) reactions, spin–parity assignments for, (E)
HOLMIUM-165 — energy level at 95 keV, lifetime of, (E)
— proton inelastic scattering at 4 MeV with Coulomb excitation, Moessbauer study of temperature spikes following, (E)
— alpha inelastic scattering at 10 MeV with Coulomb excitation, Moessbauer study of temperature spikes following, (E)
IRON — magnetic properties of ultrathin films of, Moessbauer study of
LITHIUM-8 — nuclear magnetic dipole moment of, (E)
LUTETIUM-175 — proton inelastic scattering at 4 MeV with Coulomb excitation, Moessbauer study of temperature spikes following, (E)
MOESSBAUER EFFECT — radiofrequency modulation of, analysis of sidebands from
POSITRONIUM — fine structure of, in aluminum oxide powders (J.W.R.)

1526 (HASL–261) SEMI-EMPIRICAL MODEL OF INCLUSIVE NUCLEON AND PION PRODUCTION FROM PROTON–NUCLEUS COLLISIONS. O'Brien, Keran (Health and Safety Lab. (AEC), New York). Aug 1972. 30p. Dep. NTIS.

A semi-empirical model for the production of nucleons and pions in inclusive reactions resulting from proton–nucleus collisions is described. This model has built into it the energy, angle, and atomic-weight dependence from the experimental literature. The scaling behavior, obtained by comparison with a cruder model used in cosmic-ray calculations, is in accord with measurements made at the CERN intersecting storage rings for laboratory system energies up to 1500 GeV. Comparisons with other models are made to illustrate the importance of using known integral data to obtain reliable normalizations. (auth)

1527 (INP-801) POLARIZATION OF PROTONS FROM THE ^{9}Be(d,p)^{10}Be REACTION AT E_d = 12.0 MeV. Budzanowski, A.; Freindl, L.; Karcz, W.; Kuzminski, J.; Lazarska, B.; Zipper, W. (Institute of Nuclear Physics, Krakow (Poland)). May 1972. 19p. Dep. NTIS (U.S. Sales Only).

The polarization of protons from the ^{9}Be(d,p)^{10}Be reaction at E_d = 12.0 MeV was measured for the ground-state and first excited-state transitions. The results obtained are compared with the predictions of the DWBA theory. It was found that better fits to the experimental data can be obtained using the volume absorption in the distorting potential of the deuteron elastic channel. A comparison of the polarization data with the vector analyzing power for the same reaction and at the same energy of the incident deuterons was also made. (auth)

1528 NEW EXPERIMENTAL EVIDENCE FOR THE ^{8}He NUCLEUS. Catala, J.; Pellicer, J.; Ramon, J. L.; Senent, F.; Tejerina, A. F. (Univ., Valencia). Nuovo Cim.; 11A: No. 3, 618-26 (1 Oct 1972).

There is presented the analysis and interpretation of an event consistent with the production and subsequent decay of the exotic, nucleus ^{8}He, found in the study of K^- interactions with nuclear-emulsion nuclei at different energies. (auth)

1529 STUDY OF THE ^{12}C(^{3}He,n)^{14}O REACTION IN THE ENERGY RANGE 12 TO 23 MeV. Klein, Nelson Harold. Philadelphia; Drexel Univ. (1972). 196p. University Microfilms Order No. 72-18,909.

Thesis.

A study of the ^{12}C(^{3}He,n)^{14}O reaction has been carried out to test the validity of the direct reaction two-nucleon stripping mechanism. Transitions to the ground state and excited states in ^{14}O at 5.17(1^-), 6.3(unresolved 0^+, 3^-, and 2^+ states), 7.78(2^+), and 9.74 MeV are observed. Excitation functions in the range $11.5 < E(^{3}He) < 23.5$ MeV and angular distributions at 15.0, 18.0, and 20.1 MeV are measured using a thick radiator proton recoil telescope. Absolute cross sections compare favorably with data available for this reaction at 10 to 13 MeV and at 25 MeV. The ground state excitation function data at 0° decreases smoothly to $E(^{3}He) = 20$ MeV, at which point a shallow dip is observed between 20 and 24 MeV. This is suggestive of compound nucleus effects. Distorted wave calculations of the cross section have been carried out for the bound and quasi continuum states in ^{14}O using the zero range direct reaction code DWUCK. The states in ^{14}O are assumed to be well described by the configuration mixed wave functions for the T = 1 mass 14 system, given by True(1963). Sensitivity of distorted wave cross sections to the choice of elastic scattering optical model parameters, the method used to calculate the two-nucleon form factor, approximations contained in the DWBA, and finite range considerations, are investigated. The zero range cross sections agree reasonably well with experiment for a particular choice of optical model parameters. A strong sensitivity to the choice of optical parameters for the strongly absorbed helion is found to be a consequence of the large momentum mismatch ($\Delta L = 4$) units for this reaction. The finite well form factor prescription is found to give better agreement with experiment than harmonic oscillator functions. A first order finite range calculation for the ground state transition improves the agreement with experiment. Results indicate that the direct reaction picture is valid for the reaction under study and that a distorted wave calculation is appropriate to the description, provided a proper choice is made of the optical potentials. (Diss. Abstr. Int., B)

1530 REACTION ^{6}Li(t,p)^{8}Li AT LOW TRITON ENERGY. Ciric, D. (Univ., Novi Sad, Yugoslavia); Stepancic, B.; Popic, R.; Stanojevic, D.; Aleksic, M. Fizika (Zagreb); 4: No. 3, 193-4(Jul 1972).

The excitation function of the ^{6}Li(t,p) reaction was measured at E_t = 275 to 1000 keV by determining the α yield from the decay $^{8}Li \rightarrow {}^{8}Be \rightarrow 2\alpha$. No resonance behavior was found in the region corresponding to 18.1 MeV excitation in ^{9}Be. (J.W.R.)

1531 INELASTIC SCATTERING OF NEGATIVE PION ON ^{12}C. Nishiyama, Toshio; Ohtsubo, Hisao (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 188-97(Jul 1972).

The inelastic scattering of pions on carbon 12 was investigated under the impulse approximation by using a simple nuclear model. The cross sections were calculated for the excitation of the nuclear levels with 4.4 MeV (T = 0), 9 MeV (T = 0), and 15 MeV (T = 1) in the energy range of incident pion from 120 to 280 MeV, and were compared with experiments. Even the simple model for the reaction process gave good results. (auth)

1532 SYSTEMATICS OF EFFECTIVE NEUTRON–PROTON INTERACTION IN ODD–ODD NUCLEI. Momoki, Goroh; Sasaki, Kiyoshi (Nihon Univ., Narshino, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 1, 343-4(Jul 1972).

The mass-number dependence of the strength of the effective neutron–proton interaction was studied by analyzing the experimental data of the low-lying energy levels in ^{19}F, ^{38}K, ^{40}K, ^{42}Sc, ^{90}Y, ^{92}Nb, ^{206}Tl, ^{208}Tl, ^{208}Bi, and ^{210}Bi. (W.D.M.)

1533 REACTION ^{7}Li(p,n)^{7}Be AT $E_p \rightarrow$ 17.5 MeV. Azimov, S. A.; Arifkhanov, U. R.; Gulyamov, M.; (and others) (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 173-4(Jan 1972). (In Russian).

The neutron spectrum from the reaction ^{7}Li(p,n)^{7}Be was investigated at proton energies of 17.5 MeV in the proton beam of a cyclotron. A multichannel spectrometer measuring the time-of-flight of fast neutrons was employed. (tr-auth)

1534 COMPARISON OF THE $(\alpha,2\alpha)$ AND $(\alpha,\alpha t)$ REACTIONS WITH ^{19}F AT 60.2 MeV. Chevallier, M.; Gaillard, P.; Grossiord, J. Y.; (and others) (Univ., Lyon, Villeurbanne, France). J. Phys. (Paris); 33: No. 2-3, 177-81(1972). (In French).

$(\alpha,2\alpha)$ and $(\alpha,\alpha t)$ reactions with ^{19}F were studied at 60.2 MeV in order to compare the possibilities of alpha and triton clustering in ^{19}F. These reactions, which are assumed to involve a quasi-elastic scattering mechanism, were analyzed using the PWIA. (France)

1535 EXPERIMENTAL STUDY OF THE REACTION ^{14}N(d,α) ^{12}C AT 1.7, 2.3, AND 2.9 MeV. Arribas, J. I.; Casanova, J.; Nalda, J. (Facultad de Ciencias, Valladolid, Spain). An. Fis.; 67: No. 7-8, 323-30(1971). (in Spanish).

The angular distributions of the ground state and first and second excited states of the reaction ^{14}N(d,α)^{12}C at ϵ_d = 1.7, 2.3, and 2.9 MeV were measured; the possibility of contributions from compound-nucleus and direct-interaction mechanisms is suggested. (auth)

1536 EXCITATION ENERGY OF THE FOURTH EXCITED STATE IN ^{18}F. Berka, I.; Rolfs, C.; Azuma, R. E. (Univ. of Toronto). Can. J. Phys.; 50: No. 14, 1682-4(15 Jul 1972).

The excitation energy of the $J^\pi = 5^+$, fourth excited state in ^{18}F was determined to be E_x = 1119.0 ± 0.6 keV from a measurement of the energy of the γ-ray transition to the 937 keV, first excited state. This new excitation energy removes the discrepancies in the excitation energy of resonant states based on γ-ray decay schemes involving this state. The mean lifetime was determined to be $\tau(1119) = 218 \pm 8$ ns by a delayed coincidence measurement between the γ rays populating and deexciting this state. (auth) (Canada)

1537 ALPHA-PARTICLE STATES IN ^{19}Ne AND ^{15}N. Ott, William R. Gainesville, Fla.; Univ. of Florida (1971). 115p. University Microfilms Order No. 72-21,087.

Thesis.

Angular distributions and excitation functions have been measured for the ^{16}O(^{3}He,^{3}He)^{16}O and ^{16}O(^{3}He,α)^{15}O reactions from 3.2 to 7.0 MeV ^{3}He bombarding energies and for the ^{11}B(α,α)^{11}B process from 3.6 to 7.9 MeV α-particle bombarding energies. Resonances have been observed in all excitation functions. An optical-model-plus-resonance (OMPR) analysis of previously measured elastic data indicates a level with l = 1 around 3.65 MeV ^{3}He bombarding energy in the compound system of ^{19}Ne. A two-level analysis on the ^{16}O(^{3}He,α)^{15}O data indicates levels between 4.0 and 5.0 MeV with spins of $5/2$ and $7/2$ and like parities. An R-matrix analysis confirms this assignment and makes a strong case for a $3/2$ level in the same region. These levels together with previously discovered states in this region of ^{19}Ne are in good agreement with the predictions of the α-particle core-excited threshold state model (APCETS). A modified R-matrix analysis involving the use of optical model phase shifts for the background potential scattering is used to extract level parameters for structures observed in the ^{11}B + α measurements. It is shown that an interpretation of five of the observed structures in terms of the J^π predictions of the APCETS model is consistent with the data. (Diss. Abstr. Int., B)

1538 ^{12}C($\alpha,\alpha_1\gamma_{4.43}$)^{12}C REACTION: ANGULAR CORRELATIONS AND THE 14.8 MeV LEVEL IN ^{16}O. Keller, L. G.; Kerr, R. G. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A194: No. 1, 1-11(1972).

Angular correlations in the reaction ^{12}C($\alpha,\alpha_1\gamma_{4.43}$)^{12}C have been studied for incident energies of 10.2, 10.3, and 10.5 MeV. The data were compared to a single-level compound-nucleus theory. The data substantiate the recent assignment of $J^\pi = 6^+$ to the 14.8-MeV level in ^{16}O. (auth)

1539 GENERATION OF NEUTRONS IN THICK TARGETS BOMBARDED BY 46-MeV ALPHA PARTICLES. Daruga, V. K.; Matusevich, E. S. At. Energ. (USSR); 33: No. 3, 757-65(Sep 1972). (In Russian).

Thick targets of Li, Be, C, Mg, Al, Ti, Fe, Co, Ni, Cu, Zn, Zr, Nb, Mo, Ag, Cd, Ta, W, Au, Pb, Bi, and U of natural isotopic composition were bombarded by 46 ± 1-MeV alpha particles. The spectra of secondary neutrons were studied at $\theta = 0°$ and $\theta = 90°$ relative to the beam of primary particles. Also, the angular distribution and absolute yields of secondary neutrons having energies $E_n > 0$ and $E_n \gtrsim 1.8$ MeV were found. (auth)

1540 INVESTIGATION OF THE ORIGIN OF QUASI-MOLECULAR RESONANCES IN THE INTERACTION OF ^{12}C WITH ^{12}C. Riesenfeldt, Peter William. Princeton, N. J.; Princeton Univ. (1971). 93p. University Microfilms Order No. 72-14,164.

Thesis.

Reactions of carbon nuclei incident upon carbon nuclei at energies of 4 to 6.5 MeV in the center of mass spectrum show resonances of 100 keV width correlated in several exit channels. These resonances have been thought to suggest a second minimum in the optical potential at distances comparable to the nuclear radius. The optical potential between two nuclei has been derived on the basis of a Strutinski renormalized double-center-shell model. Po-

tentials calculated in this way spanning several degrees of freedom for deformation showed no indication of a secondary minimum in the potential energy surfaces. The agreement between the calculations and binding energies as well as experimental optical potentials was good for $^{16}O + ^{16}O$, $^{12}C + ^{12}C$, and $^{18}O + ^{18}O$. Investigations of resonances in the reactions in single-minimum wells are also considered. It is found that a single-minimum well is unable to reproduce the spacing and ordering of angular momenta of the resonances. Finally, alpha particle clusters and excited state configurations are considered and suggested as the causes of the resonances. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, $20 \leq A \leq 38$

Refer also to abstracts 39, 1525, 1532, 1539, 1552, and 1635.

1541 (TID-26189) **$^{31}P(^3He,p)^{33}S$ REACTION. Graue, A.; Lien, J. R.; Rasmussen, L.; Sandvik, G. E. (Bergen Univ. (Norway). Dept. of Physics); Cosman, E. R. (Massachusetts Inst. of Tech., Cambridge). [nd]. Contract AT(30-1)-2098. 26p. Dep. NTIS.**

The $^{31}P(^3He,p)^{33}S$ reaction has been studied at 12.0-MeV incident energy. High-resolution magnetic analysis of the reaction protons enabled 36 levels to be identified up to $E_x = 8.3$ MeV in ^{33}S. Detailed angular distributions were extracted for most of the transitions. DWBA analyses using the reaction formalisms of Glendenning and Bayman were compared, and the predictions of the theoretical wave functions of Glaudemans were tested. Presence of L = 0, 1, 2, and 3 stripping amplitudes was tentatively inferred for several levels, and consequent spin assignments suggested. Three analogs of ^{33}P levels were seen, and a brief discussion of Coulomb and symmetry energies is given. (Norway)

1542 STUDY OF ^{22}Ne VIA THE $^{20}Ne(t,p\gamma)^{22}Ne$ REACTION. Howard, A. J. (Yale Univ., New Haven); Hirko, R. G.; Bromley, D. A.; Bethge, K.; Olness, J. W. (Nuovo Cim.; 11A No. 3, 575-89 (1 Oct 1972).

The ^{22}Ne states lying in the excitation energy range $5.14 \leq E \leq 7.48$ MeV were studied via the $^{20}Ne(t,p\gamma)^{22}Ne$ reaction at a bombardment energy of 3.00 MeV. Proton–gamma angular correlation studies were performed in a collinear geometry. The results establish J = 1 assignments for the 5.33-, 6.82-, 7.05-, and 7.48-MeV ^{22}Ne states and a J = 2 assignment for the 6.12-MeV level. Probable spin assignments of J = 3 and 1 are found for the 5.63- and 7.35-MeV levels, respectively. The contradictory nature of information concerning the 5.92-MeV state as obtained in the present study and a previous one is discussed. The results of the present and previous studies on ^{22}Ne levels below $E_x = 7.5$ MeV are brought together and compared with an existing deformed-shell-model calculation. (5 figures, 3 tables) (auth)

1543 STUDY OF THE $^{28}Si(t,\alpha)^{27}Al$ PICKUP REACTION. Purdy, James Aaron. Austin, Tex.; Univ. of Texas (1971). 79p. University Microfilms Order No. 72-19,652.

Thesis.

The $^{28}Si(t,\alpha)^{27}Al$ pickup reaction has been studied utilizing the triton beam from the University of Texas 4 MeV Van de Graaff accelerator. The angular distributions of particles were measured at bombarding energies of 2.50, 2.80, and 3.15 MeV from 25° to 145° at intervals of 5° in the laboratory frame. The 3.15 MeV data were subjected to a DWBA analysis using published triton and α particle optical model parameters. The ground state transition was well described by this theory. However, the fits of the excited level angular distributions were poor, indicating that they were probably excited via some multistep processes, presumably involving the excitation of the ^{28}Si core. (Diss. Abstr. Int., B)

1544 INVESTIGATION OF (p,d) REACTIONS ON ^{32}S AND ^{34}S IN A BEAM OF POLARIZED PROTONS. Eskyud'e, Zh. L.; Gosse, Zh.; Lombar, R. L.; (and others) (Center of Nuclear Research, Saclay, France). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 140-2(Jan 1972). (In Russian).

The asymmetry and absolute values of the differential transverse cross sections were measured for (p,d) reactions for 24.5 MeV protons on ^{32}S and ^{34}S. A Born approximation of the distorted waves (BPIV) was used in an analysis of the experimental results obtained, allowing for spin-orbital interaction. (tr-auth)

1545 STUDY OF ^{21}Na EXCITED STATES. Lambert, M. (Univ., Lyon, Villeurbanne, France); Midy, P.; Drain, D.; (and others). J. Phys. (Paris); 33: No. 2-3, 155-76(1972). (In French).

The following excited states of ^{21}Na were studied by analyzing the reactions $^{20}Ne(p,p)$, $^{20}Ne(p,p')$, and $^{20}Ne(p,\gamma)$: 4.15, 4.293, 4.47, 4.98, and 5.03 MeV. The properties of ^{21}Na states having energies of less than 6 MeV are compared with those of the corresponding states of ^{21}Ne and with predictions made using the Nilsson model. (France)

1546 LIFETIMES OF ENERGY LEVELS IN ^{30}P. Lukko, A.; Penttinen, S.; Anttila, A.; Bister, M. (Univ. of Helsinki). Phys. Scr.; 5: No. 1-2, 63-5(1972).

The mean lives have been determined with the Doppler-shift-attenuation method for levels in ^{30}P populated by the gamma decay of the E_p = 1470 keV, 1505 keV, 1686 keV, 1746 keV, and 1749 keV resonances in the reaction $^{29}Si(p,\gamma)^{30}P$. The measured mean lives are given for seven excited states. Upper or lower limits of the mean lives are obtained for some other states. (auth) (Sweden)

1547 NATURE OF THE β-DECAY ELECTRONS. Bagge, Erich (Institut fuer Reine und Angewandte Kernphysik, Kiel); Greim, Ludwig. Atomkernenergie; 20: No. 1, 1-12(Sep 1972). (In German).

It is the intention of this investigation to prove, for the example of ^{32}P electrons, whether these electrons as free particles can be excited to higher internal energies. For that purpose the bremsstrahlung spectrum of ^{32}P electrons in a silicon semiconductor and the energy distribution of the $\beta-\gamma$ coincidence electrons were measured and compared with the corresponding spectra calculated under the assumption of electrons which can and cannot be excited. The observed $\beta-\gamma$ coincidence spectrum for the energy sums of the electrons and the quanta shows a large displacement of the maximum energy from 0.357 to 0.77 MeV, exactly in the expected direction. In addition, it was found that the energy distribution of the ^{32}P electrons measured by a semiconductor device does not fit in the distribution of the momenta of the same particles if the calculation from the one to the other spectrum is done under the assumption that electrons cannot be excited, while it could be possible for particles of allowed internal excitation. (9 figures, 1 table) (auth)

1548 PART I. TOTAL YIELD MEASUREMENTS FOR THE $^{21}Ne(\alpha,n)^{24}Mg$ REACTION. PART II. A STUDY OF THE $^{12}C(He,p)^{14}N$ REACTION. Mak, Hay Boon. Pasadena, Calif.; California Inst. of Tech. (1972). 236p. University Microfilms Order No. 72-22,609.

Thesis.

The total cross section for the reaction $^{21}Ne(\alpha,n)^{24}Mg$ has been measured in the energy range 1.49 MeV $\leq E_{cm} \leq$ 2.6 MeV. The cross-section factor, S(O), for this reaction has been determined, by means of an optical model calculation, to be in the range 1.52×10^{12} mb-MeV to 2.67×10^{12} mb-MeV, for interaction radii in the range 5.0 fm to 6.6 fm. With $S(O) \approx 2 \times 10^{12}$ mb-MeV, the reaction $^{21}Ne(\alpha,n)^{24}Mg$ can produce a large enough neutron flux to be a significant astrophysical source of neutrons. The reaction $^{12}C(^3He,p)^{14}N$ has been studied over the energy range 12 MeV $\leq E_{lab} \leq$ 18 MeV. Angular distributions of the proton groups leading to the lowest seven levels in ^{14}N were obtained. Distorted wave calculations, based on two-nucleon transfer theory, were performed, and were found to be reliable for obtaining the value of the orbital angular momentum transferred. The present work shows that such calculations do not yield unambiguous values for the spectroscopic factors. (Diss. Abstr. Int., B)

1549 RADIATIVE ALPHA CAPTURE IN ^{32}S, ^{34}S, AND ^{23}Na. Clarke, Richard Edwards Jr. Gainesville, Fla.; Univ. of Florida (1971). 109p. University Microfilms Order No. 72-21,051.

Thesis.

The $^{32,34}S(\alpha,\gamma)^{36,38}Ar$ reactions were studied over an energy range E_α = 3.2 to 4.3 MeV. Of the thirteen resonances observed in this energy region, three are attributed to ^{32}S and ten to ^{34}S. The excitation energies and resonance strengths are reported. The main decay of all levels is directly to the ground state, permitting definite spin and parity assignments to all resonances from angular distribution data. The resonance strengths support the isobaric spin selection rule for electric dipole transitions in self-conjugate nuclei. In a preliminary investigation of the radiative alpha capture in ^{33}S and ^{36}S between E_α = 2.5 and 4.1 MeV no resonances attributable to excited states in ^{37}Ar or ^{40}Ar were discovered. The $^{23}Na(\alpha,\gamma)^{27}Al$ reaction was studied over an incident alpha particle energy of 3.2 to 4.1 MeV. Spectra were taken on fourteen of the more than thirty resonances observed in this energy region. The decay schemes and branching ratios were found for each of the resonances on which spectra were taken. The efficiency curves for the 38 cm^3 Ge(Li) detector used in this work were calculated. The excitation functions for the $^{23}Na(\alpha,p_1\gamma)^{26}Mg$, $^{23}Na(\alpha,p_2\gamma)^{26}Mg$, and $^{23}Na(\alpha,n)^{27}Al$ reactions between E_α = 3.2 to 4.1 MeV are reported. Angular distributions were taken on two resonances that appear in the $^{23}Na(\alpha,\gamma)^{27}Al$ excitation function in order to make preliminary limitations on the spin of the unbound levels in ^{27}Al. (Diss. Abstr. Int., B)

1550 ELASTIC AND INELASTIC SCATTERING OF 24.5-MeV POLARIZED PROTONS BY ^{32}S AND ^{34}S. Plavko, A. V.; Kamitsubo, Kh.; Gosse, Zh.; (and others). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 625-30(Mar 1972). (In Russian).

Differential transverse cross sections and data on the asymmetry of inelastic scattering of 24.5-MeV protons by ^{32}S and ^{34}S were obtained in connection with the excitation of low-lying collective states. Preliminary results are shown for a method of coupled channels with the use of a vibrational model for 2^+ and 3^- collective states of ^{32}S and ^{34}S. Parameters of optical potentials for these two nuclei were calculated from deformation parameters and the scattering data. (K.S.W.)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 1532, 1539, 1573, 1635, and 1638.

1551 (COO-2171-9) TRANSFORMATION PROPERTIES OF THE EFFECTIVE TRANSITION OPERATOR. Goode, Philip; West, Bruce J. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1972. Contract AT(11-1)-2171. 19p. (UR-401). Dep. NTIS.

A multipole decomposition of the matrix elements of the effective transition operator was made in both particle–particle (pp) and hole–hole (hh) nuclei. It was found that the many-body part of this operator may be represented by an effective two-body multipole coefficient. This coefficient transforms by a phase between the pp and hh nuclei which is different from the one-body part of the operator. This formalism was applied to the ^{42}Sc (pp) and ^{54}Co (hh) cases, where it was seen that the general structure of ^{42}Sc can be predicted from that of ^{54}Co. (auth)

1552 (FRNC-TH-222) EXPERIMENTAL STUDY OF ^{40}Ca, ^{42}Ca, ^{44}Ca, AND ^{48}Ca EXCITED STATES. Tellez-Arenas, Antoine (Paris Univ., Orsay (France)). 1971. 149p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Multiparametric recording of coincident events enabled a systematic study of the energies and electromagnetic branching ratios of a large number of states excited by the scattering of 12-MeV protons from ^{40}Ca, ^{42}Ca, ^{44}Ca, and ^{48}Ca to be performed. Already known results were confirmed, and, in addition more than 60 new levels were identified, and the branching ratios of more than 100 levels were measured for the first time. The levels of ^{40}Ca and ^{42}Ca were classified from their γ transitions and the $^{39}K(^3He,d\gamma)^{40}Ca$, $^{41}K(^3He,d\gamma)^{42}Ca$, and $^{36}Ar(^7Li,t)^{40}Ca$ reactions at incident energies of 18 and 28 MeV respectively. The ^{40}Ca levels below the 9 MeV excitation level were divided into 4 groups having given structures: 1 particle-1 hole, 2 particles-2 holes, 2n particles-2n holes, and (2n + 1) particles-2(n + 1) holes. The properties of the levels of each group are compared to the theoretical predictions of the models, measured mean-life values being used. (France)

1553 (LYCEN-7221) REACTIONS (d,α) ON ^{46}Ti AND ^{48}Ti AT 26.7 MeV. Guichard, A.; Bedjidian, M.; Grossiord, J. Y.; Gusakow, M.; Pizzi, J. R.; Ruhla, C. (Lyon Univ. France. Institut de Physique Nucleaire). Mar 1972. 21p. (In French). Dep. NTIS (U.S. Sales Only).

The (d,α) reactions on ^{46}Ti and ^{48}Ti with 26.7 MeV incident deuterons were investigated. Angular distributions of the most excited levels were obtained. The theoretical analysis was performed using the two nucleon transfer theory of Glendenning. (France)

1554 MEASUREMENT OF THE MAGNETIC SUBSTATES OF THE FIRST 3^- STATE OF ^{40}Ca EXCITED THROUGH THE INELASTIC SCATTERING OF 20.3 MeV PROTONS. Lewellen, Thomas Kirby. Seattle; Univ. of Washington (1972). 106p. University Microfilms Order No. 72-20,875.

Thesis.

A study of the reaction mechanism by which protons excite the first 3^- state of ^{40}Ca has been undertaken. The experimental method made use of the angular correlation between the scattered protons and gamma rays which are emitted when the excited nucleus returns to the ground state. This is the first investigation in which coincident methods have been used to study the proton excitation of a 3^- state. Correlations were measured for a variety of geometrical arrangements. The gamma detectors were placed in the reaction plane, perpendicular to the reaction plane and also midplane, that is, on a cone subtending a finite angle with respect to the perpendicular to the reaction plane. Since the correlation functions are bilinear functions of the various inelastic scattering amplitudes, they provide a source of new information about the scattering process beyond that given by measurements of the inelastic scattering cross section alone. The additional quantities best determined in the present experiments are the substate probabilities and substate cross sections. These quantities exhibit considerably more structure than the inelastic cross section. The theoretical predictions of the data were based on the generalized optical model, a conceptually simple phenomenological theory which has enjoyed some previous success in describing the proton inelastic cross sections, asymmetries, and gamma-ray correlation functions when the first 2^+ states of a variety of intermediate mass nuclei are excited. When applied to the excitation of a 3^- level, this theory again gives a reasonable account of most of the data; in fact the theoretical investigation suggests that the correlation measurements place constraints on the parameters of the underlying spherical optical model. In particular, agreement with the observed substate populations for proton scattering angles less than 110° sets limits on the values of the spin-orbit potential. (Diss. Abstr. Int., B)

1555 STUDY OF LEVELS IN ^{51}Cr THROUGH $^{51}V(p,n\gamma)$ REACTION. Lal, B.; Sahai, Baldev (Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 75: No. 6, 269-77(Jun 1972).

The low-lying levels in ^{51}Cr have been populated by $^{51}V(p,n\gamma)^{51}Cr$ reaction. The angular distribution of the ground state electromagnetic transitions from 1165, 1353, 1479 and 1557 keV states has been measured. The results are compared with the Hauser–Feshbach model of the statistical theory of nuclear reactions. The spins for the levels at 1165, 1479 and 1557 keV are shown to be $9/2^-$, $11/2^-$ and $5/2^-$ respectively. (auth)

1556 METHOD OF VARIATION AFTER PROJECTION APPLIED TO ^{44}Ti. Shikata, Yozo (Aoyama Gakuin Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 1, 345-6(Jul 1972).

One of the possible improvements of the Hartree–Fock (HF) method of variation after projection (VP) consists in the use of an angular momentum eigenstate as a trial wave function. The eigenstate is projected from a determinant whose single-particle orbitals are variationally determined. This method has been previously applied to simple nuclei and compared with the HF method. The comparisons have shown that the two methods give practically identical results in the case of ^{20}Ne. However, the comparison is incomplete for ^{44}Ti, and is completed in this short note. (W.D.M.)

1557 HIGH-RESOLUTION PROTON SCATTERING FROM ^{48}Ti. Prochnow, N. H. (Duke Univ., Durham, N. C.); Newson, H. W.; Bilpuch, E. G.; Mitchell, G. E. Nucl. Phys.; A194: No. 2, 353-79(1972).

Differential cross sections were measured for $^{48}Ti(p,p)$ and $^{48}Ti(p,p_1)$ at four angles between E_p = 1.8 and 3.1 MeV. The overall energy resolution was 250 to 350 eV. Spins, parities, total widths and partial widths were extracted for 301 resonances. Two analog states were observed, and spectroscopic factors and Coulomb energies determined for these analog states. A large positive correlation was observed between the elastic and inelastic widths for one analogue; no correlation was observed away from the analogue. The spacing distributions of the $s_{1/2}$ and $p_{1/2}$ resonances (after correction for the energy dependence of the average spacing) are in reasonable agreement with the Wigner distribution. The $s_{1/2}$, $p_{1/2}$ and $p_{3/2}$ proton strength functions were determined. (auth)

1558 LEVEL STRUCTURE OF ^{54}Mn FROM THE $^{54}Cr(p,n\gamma)$ REACTION. Ogawa, M.; Taketani, H. (Tokyo Inst. of Tech.) Nucl. Phys.; A194: No. 2, 259-91(1972).

Excitation functions and angular distributions of γ-rays in the reaction $^{54}Cr(p,n\gamma)^{54}Mn$ were measured in order to establish the spins and parities of levels in ^{54}Mn. Gamma-ray spectra from the $^{51}V(\alpha,n\gamma)^{54}Mn$ reaction were also measured. Using the theoretical predictions of the statistical compound-nucleus model, unique spin assignments were obtained for the 54.5 keV (2^+), 156.2 keV (4^+), 368.1 keV (5^+), 407.4 keV (3^+), 1009.9 keV (3^+) and 1374.5 keV (2) levels in ^{54}Mn. The most probable spins for the other levels were found to be 838.9 keV (4 or 5), 1073 keV (4, 5, 6 or 7), 1136.2 keV (4, 5 or 6), 1390.7 keV (1 or 0^+), 1454.2 keV (1^+ or 0^+) and 1508.7 keV (2 or 3). Branching ratios and multipole mixing ratios for the γ-rays observed were also obtained. These results were compared with recent theoretical predictions. (auth)

1559 MEAN LIFETIME OF LEVELS AT 53.2 keV AND 111.5 keV AND MAGNETIC MOMENT OF LEVEL AT 111.5 keV IN ^{58}Co. Haas, B. (Centre de Recherches Nucleaires, Strasbourg); Gehringer, V.; Chevallier, J.; Merdinger, J. C.; Bozek, E. Nucl. Phys.; A194: No. 2, 249-58(1972). (In French).

To study the lowest levels of ^{58}Co, nγ angular correlations (method II) and g-factor and lifetime measurements have been

performed using the $^{58}Fe(p,n\gamma)^{58}Co$ reaction. The lifetime of the 111.5 keV level was found to be $T_{\frac{1}{2}} = 0.18 \pm 0.03$ ns. The lifetime of the 53.2 keV level was remeasured and found to be $T_{\frac{1}{2}} = 10.4 \pm 0.3$ μs. The g-factor of 111.5 keV state was determined to be $g = +0.74 \pm 0.13$ using the IPAD method. Branching and mixing ratios have also been obtained. Values of $J^\pi = 4^+$ and 3^+ were assigned to the levels at 53.2 keV and 111.5 keV, respectively. (auth)

1560 ELASTIC SCATTERING OF NEUTRONS FROM ^{52}Cr. Haensgen, H.; Nitzsche, M. (Technische Univ., Dresden). Kernenergie; 15: No. 3, 97-9(Mar 1972). (In German).

Angular distribution of the polarization of 2.9-MeV neutrons scattered elastically from ^{52}Cr was measured and analyzed on the basis of the optical model. The comparison with similar evaluations of the differential elastic cross section shows that a set of parameters may be found which sufficiently represents both polarization power and differential cross section and, at the same time, comes very near to the set of parameters given by Becker et al. (auth)

1561 UNIQUENESS OF ^{56}Fe AS A PRIMARY STANDARD FOR ATOMIC MASSES. Durnford, A. M. I. A. W. (Univ. of Western Ontario, London). J. Phys., A (London); 5: No. 10, L106-8(Oct 1972).

A recent evaluation of atomic masses confirms that ^{56}Fe has uniquely the "least" atomic mass per baryon, $\frac{A}{Z}M/A$. Thus, with ^{56}Fe as the primary standard ($^{56}_{26}M = 56$), all other atomic masses would be greater than the mass number A and the corresponding "mass excesses" would be not only "positive" but also "maxima." Moreover, a mass excess relative to ^{56}Fe is potentially the largest "portion" of the atomic mass that can be transformed into energy (assuming conservation of baryon number); it therefore has a unique physical significance. Accordingly, a plot of the mass excesses against A and Z would provide a unique "potential-energy surface" which should be useful in the representation of nuclidic transformations that involve a change in A (e.g., α decay) as well as those with A = constant. (auth)

1562 4.61 AND 5.15 MeV LEVELS OF ^{48}Ca. Tape, J. W. (Rutgers-The State Univ., New Brunswick, N. J.); Hensler, R.; Benczer-Koller, N.; MacDonald, J. R. Nucl. Phys.; A195: No. 1, 57-64(1972).

Particle-γ angular-correlation and lifetime studies of the fourth and fifth excited states of ^{48}Ca give $E_x = 4.613$ MeV, $J^\pi = 3^{(+)}$, $\tau_m = 1.8 \pm 0.6$ ps and $E_x = 5.152$ MeV, $J^\pi = (5^-)$, $\tau_m = 2.21 \pm 0.04$ ns, respectively. The properties of the first five excited states of ^{48}Ca are discussed with reference to recent shell-model calculations; no compelling evidence of collective structure is indicated. (auth)

1563 GAMMA TRANSITION PROBABILITIES IN THE ^{58}Co NUCLEUS. Gehringer, C.; Haas, B.; Chevallier, J.; Britz, J. (CRN, Strasbourg). Nucl. Phys.; A195: No. 1, 65-74(1972). (In French).

To study ^{58}Co levels up to excitations of 1184.5 keV, n-γ angular correlations and lifetimes by the Doppler-shift attenuation method have been performed. Spins of 3^+, 5^+, 4^+, and 3^+ have been assigned to the 365.6, 373.7, 457.4, and 1040.1 keV levels, respectively. The lifetimes for all the levels, except that at 1075.4 keV, have been determined. (auth)

1564 SPECTROSCOPY OF ^{54}Fe VIA THE REACTION $^{54}Fe(p,p'\gamma)^{54}Fe$ AT 10 MeV. Moss, J. M.; Hendrie, D. L.; Glashausser, C.; Thirion, J. (Univ. of California, Berkeley). Nucl. Phys.; A194: No. 1, 12-48(1972).

In the $^{54}Fe(p,p'\gamma)^{54}Fe$ reaction at 10 MeV, angular correlations of gamma rays coincident with protons detected near 180°, have been measured. From an analysis of the angular correlations, unambiguous spin assignments have been made for the 3.345(3), 4.074(3), 4.579(2), 4.781(3), and 4.949(4) MeV states. Model-dependent spin assignments have been made for several other states. The angular correlation analysis also yielded multipole mixing ratios for many transitions and branching ratios for the decay of all states of ^{54}Fe below 5 MeV. From the same data, an analysis of the Doppler shifts of the coincident gamma rays allowed determination of the lifetimes of the 1.409, 2.959, 3.164, 3.836, 4.048, 4.074, 4.265, 4.287, 4.781 and 4.949 MeV states. Utilizing all the measured quantities, estimates have been of the strengths of 20 E2, 9 M1, and 4 E1 transitions. To aid in understanding the nature of the observed levels, the positions of various np-mh states have been estimated using a monopole residual interaction. It is found that 2p-4h states as well as 1p-3h states may occur at low excitation energies. The 2.540 MeV (0_2^+) state is probably of the configuration 2p-4h. The decay properties of all states below 3.5 MeV are compared to the predictions of theoretical calculations in which 1p-3h proton ($2p_{\frac{1}{2}}$ and $1f_{\frac{1}{2}}$) excitations were considered. (auth)

1565 ANALOGUE RESONANCES OF LOW LYING LEVELS OF ^{52}V IN THE $^{51}V(p,\gamma)^{52}Cr$ REACTION. Price, H. G. (Oxford Univ.). J. Phys., A (London); 5: No. 10, 1524-8(Oct 1972).

The analogs of the ^{52}V levels at 0.793 and 0.846 MeV were examined as resonances in the $^{51}V(p,\gamma)^{52}Cr$ reaction at proton energies of 1.567 and 1.629 MeV. The resonance at 1.567 MeV and hence the 0.793 MeV ^{52}V level was assigned J^π of 3^+ and the most probable J^π value for the 1.629 MeV resonance and hence the 0.846 MeV ^{52}V level is shown to be 4^+. These results are consistent with previous theoretical calculations of the ^{52}V levels. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 39, 581, 1539, and 1598.

1566 (AD-736842) DISTORTED-WAVE BORN-APPROXIMATION ANALYSIS OF THE $^{89}Y(^3He,\alpha)^{88}Y$ REACTION. Park, Yong S.; Jones, Heber D.; Bainum, David E.; Barrows, Austin Jr. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Dec 1971. 41p. (BRL-1564). NTIS.

Detailed descriptions are given of the scattering facilities, experimental procedures, and methods of analysis with which various direct nuclear reactions have been studied at this laboratory. These studies are carried out to provide supplementary information regarding reaction mechanisms for use in the neutron cross section program. Emphasis is placed on detailed checks of the functions and capabilities of the computer codes available for the analysis of direct reactions. Also, the reliability of the distorted-wave Born-approximation (DWBA) calculations and parameters entering into them were thoroughly investigated for the case of a specific single-nucleon-transfer reaction, the $^{89}Y(^3He,\alpha)^{88}Y$ reaction. (auth)

1567 (COO-119-246, pp 352-7) ^{83}Rb HALF-PERIOD DETERMINATION. Lloyd, Ray D.; Mays, Charles W.; Gaufin, Susan S.; Atherton, David R. 31 Mar 1972.

In Research in radiobiology.

Serial measurement of the gamma-ray emission rate from two ^{83}Rb sources over periods of 312 and 366 days yielded calculated half-periods of 85.0 ± 2.1 and 86.3 ± 1.8 days, respectively. These values are in substantial agreement with the accepted half-period for ^{83}Rb of 83 days. (auth)

1568 (IS-T-520) GAMMA-RAY DECAY SCHEMES FOR ^{89}Kr AND ^{89}Rb. Henry, Eugene Albert (Ames Lab., Iowa). Aug 1972. Contract W-7405-eng-82. 134p. Dep. NTIS.

Thesis.

A study of gamma-ray de-excitation following the beta decay of ^{89}Kr and ^{89}Rb produced by the TRISTAN on-line isotope separator is reported. Measurements of gamma-ray energies and intensities were made using Ge(Li) detectors. Level schemes were constructed for ^{89}Rb and ^{89}Sr with the aid of gamma-gamma coincidence information, and beta branching was determined from equilibrium data and gamma-intensity balances. The excited levels of ^{89}Sr appear to be explained by single-particle states and the coupling of single-particle states to the vibration states of ^{88}Sr. The ^{89}Rb nucleus is shown to have a complex level scheme and will require further studies to clarify the picture of its nuclear structure. (auth)

1569 (LYCEN-7218) EXPERIMENTAL CONTRIBUTION TO THE STUDY OF THE STATISTICAL THEORY OF THE DE-EXCITATION OF THE NUCLEUS. Demeyer, Albert (Lyon Univ. (France). Institut de Physique Nucleaire). Feb 1972. 74p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

An attempt was made to experimentally verify the statistical theory of the de-excitation of the nucleus. The excitation functions obtained for an ^{85}Rb target irradiated with α particles are compared with those obtained for an ^{88}Sr target irradiated with protons. This comparison enables the independent formation and de-excitation hypothesis on the behavior of the compound nucleus to be tested. The mean recoil paths were measured. The isomer ratios were determined for these nuclei. The discrepancies existing between these results and those of the Fermi gas model are confirmed using the superconductor model and the Lang and Le Couteur model. The particle spectra of the (α,α') reaction and their angular distribution in the case of a Zr target bombarded at 54 MeV were investigated. The persistency of the effects of pairing forces at high excitation energy was verified from measurements of the neutron spectra of ^{116}Sn and ^{117}Sn bombarded with 20 MeV α beams. (France)

1570 EXCITATION CROSS SECTIONS OF THE FIRST LEVELS 2^+ OF Se NUCLEI DURING INELASTIC NEUTRON SCATTERING. Konobeevskii, E. S.; Musaelyan, R. M.; Popov, V. I.; Surkova, I. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 163-8 (Jan 1972). (In Russian).

The energy dependence of the cross section of the $(n,n'\gamma)$ reaction has been investigated for the first levels 2^+ of the even Se isotopes. The average experimental cross sections substantially exceed those expected from the optical model without allowing for the correlation of resonance widths. (tr-auth)

1571 LIFETIME OF THE 1.037 MeV STATE OF ^{66}Zn. Kaipov, D. K.; Kosyak, Yu. G.; Smirin, L. N.; Mubnyi, Yu. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 137-9(Jan 1972). (In Russian).

The method of γ resonance scattering by ^{66}Zn leads to a determination of the lifetime of the 1.037 MeV level = $(2.2 \pm 0.3) \times 10^{-12}$ sec. Radioactive ^{66}Cu in the form of the metal was employed as the source of γ radiation. (tr-auth)

1572 INFLUENCE OF NONLOCALITY ON INELASTIC α-PARTICLE SCATTERING. Tokarevskii, V. V. (Inst. of Nuclear Research, Kiev). Yadern. Fiz.; 15: No. 15, 898-904 (May 1972). (In Russian).

An influence of a nonlocal interaction potential on inelastic scattering of 27.2-MeV α particles by ^{64}Zn nucleus has been investigated in the local energy approximation. The calculations were made for four discrete optical potential parameter sets: V = 56.7, 125, 187, and 296 MeV which describe the differential elastic scattering cross sections equally well. The nonlocal interaction corrections are shown to be essential for the deep optical potentials and display themselves in the decreasing of the differential cross sections at scattering angles $\theta \geq 90°$. The influence of the interaction nonlocality on the inelastic α particle scattering is insignificant for the region of scattering angles $\theta \leq 90°$ and for the shallow optical potentials. (auth)

1573 TOTAL CROSS SECTIONS FOR REACTIONS WITH 13.6 MeV DEUTERONS IN THE REGION A ~ 60. Dubar, L. V.; Nemets, O. F.; Slyusarenko, L. I.; Tokarevskii, V. V. (Inst. of Nuclear Research, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 158-62(Jan.1972). (In Russian).

Total reaction cross sections were measured by the charge accumulation method for 13.6 MeV deuterons on the nuclei Fe, Co, Ni, ^{65}Cu, and Zn. Cross section values obtained were, respectively, 1,504 ± 40; 1,484 ± 37; 1,422 ± 35; 1,602 ± 48; and 1,513 ± 39 mbarn, which were in good agreement with those calculated from an optical model. (tr-auth)

1574 THERMAL NEUTRON CAPTURE IN NATURAL KRYPTON. Mattsson, C. G.; Arnell, S. E.; Jonsson, L. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 5: No. 1-2, 58-62 (1972).

The energies and intensities of γ radiation from thermal neutron capture in natural krypton were determined by means of a Ge(Li) pair and anti-Compton spectrometer. An internal reactor target was used. The reaction Q-value and the energies of excited states resulting from the ^{83}Kr(n,γ)^{84}Kr reaction were deduced. The negative parity states of ^{84}Kr are discussed. (auth) (Sweden)

1575 SPINS AND γ-MULTIPOLARITIES IN THE DECAY OF ^{59}Fe. Subrahmanyam, V. (Boston Coll., Chestnut Hill, Mass.). J. Inorg. Nucl. Chem.; 34: No. 11, 3319-22(Nov 1972).

The intensities of the 1.10- and 1.29-MeV γ rays in coincidence with x rays from K-electron conversion were measured, and the coincident intensity ratio was found to be 8.5 ± 0.2. This ratio was utilized in deducing M1 and E2 characters for 145- and 192-keV transitions, respectively. The directional correlation of the 145-keV to 1.29-MeV cascade was measured, and a value of $A_2 = -0.09 \pm 0.01$ obtained. From these and other published data arguments were presented in favor of spin assignments of $\frac{5}{2}$, $\frac{3}{2}$, and $\frac{1}{2}$ for the ^{59}Co levels at 1.10, 1.29, and 1.43 MeV, respectively. (auth)

1576 LIFETIME OF EXCITED STATES OF ^{65}Zn AND ^{67}Zn NUCLEI. Shubnyi, Yu. K.; Lysikov, Yu. A. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 24-30(1971). (In Russian).

The lifetimes of the 115-keV state of ^{65}Zn and the 184-keV state of ^{67}Zn were found to be $(4.9 \pm 0.9) \times 10^{-10}$ sec and 2×10^{-10} sec, respectively. Limiting values were obtained for the ^{65}Zn levels at 769, 867, 1047, 1342, and 1461 keV, and for the ^{67}Zn level at 393 keV. The γ transition with energy 115 keV of the ^{65}Zn nucleus was determined to be type M1. Radioactive sources of ^{65}Ga ($T_{\frac{1}{2}}$ = 15.2 min) and of ^{67}Ga ($T_{\frac{1}{2}}$ = 77.9 hr) were obtained by the ^{63}Cu (α,2n) reaction and the ^{65}Cu (α,n) reaction. (tr-auth)

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Refer also to abstracts 581, 1525, 1532, 1539, 1569, and 1635.

1577 (COO-119-246, pp 346-51) NOTE ON THE HALF-PERIOD OF ^{133}Ba. Lloyd, Ray D.; Mays, Charles W. 31 Mar 1972.

In Research in radiobiology.

The ^{133}Ba in a sealed source was found to have decayed with a half-period of about 11 years over a 4.5-yr span of time, based on a comparison with the decay of ^{137}Cs. This observation tends to confirm the values for the ^{133}Ba half-period of about 10 to 11 years reported by several authors, but disagrees with values of about 7 to 8 years reported by other investigators. An intensive search of the literature revealed a phantom reference for the previously accepted 7.2 year value of the ^{133}Ba half-period. From recent work of other investigators, 10.5 ± 0.5 years is the best estimate of the true half-period of ^{133}Ba. (auth)

1578 (FRNC-TH-218) ANALOGUE STATES OF ^{140}La. Lamehi Rachti, Mohammad (Paris Univ., Orsay (France)). 1971. 51p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Isobaric ^{140}La analog states were observed in the elastic and inelastic scattering of protons having energies between 9 and 12 MeV by ^{139}La. A quantitative and qualitative analysis of the first resonances observed in the elastic and inelastic scattering for the first excited states of the target was made. Spectroscopic information was obtained about the levels: their structure, their overlapping with the wave functions of different excited states of the target. It was not possible to directly obtain the partial widths. An analytical method was developed which consists of introducing theoretical partial widths and comparing the cross sections obtained with those obtained experimentally. (France)

1579 (KAPL-P-3950) ^{137}Cs AND ^{134}Cs HALF-LIVES DETERMINED BY MASS SPECTROMETRY. Dietz, L. A.; Pachucki, C. F. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 12p. Dep. NTIS.

An internal standard technique and the precision of ion-counting mass spectrometry were used to follow the decay of ^{137}Cs for a period of 11 years. The final value for the ^{137}Cs half-life is 30.174 yr ± an uncertainty (precision) of 0.034 year at the 99% confidence level. In a separate experiment, spanning 9.8 year and undertaken to test certain aspects of the internal standard technique, the ^{134}Cs half-life was measured to be 2.062 yr ± an uncertainty (precision) of 0.005 yr at the 99% confidence level. (auth)

1580 (NP-19438) ANNUAL REPORT, 1970. Poddar, R. K.; Basu, B. (eds.) (Saha Inst. of Nuclear Physics, Calcutta (India)). Jul 1971. 165p. Dep. NTIS (U. S. Sales Only).

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1581 (ORNL-4791, pp 1-20) NUCLEAR CHEMISTRY. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

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1582 (RCN-176) RESONANCE ACTIVATION INTEGRAL FOR $^{109}Ag(n,\gamma)^{110m}Ag$. Aaldijk, J. K.; Korstjens, H. M. M.; Zijp, W. L. (Reactor Centrum Nederland, Petten). 15 Sep 1972. 15p. Dep. NTIS (U. S. Sales Only).

Results are given of determination of the values for the 2200 m/s cross section σ_0, the resonance integral I, and the Westcott s_0 factor for the reaction $^{109}Ag(n,\gamma)^{110m}Ag$. The data are derived from several reactor irradiations of resonance detectors performed in the period from 1967 to 1971. Absolute values for σ_0 and I could be derived by applying the cadmium ratio method and using cross section data of the $^{197}Au(n,\gamma)^{198}Au$ reaction as reference. The following results for the reaction $^{109}Ag(n,\gamma)^{110m}Ag$ were obtained: $\sigma_0 = 458 \pm 7$ fm^2; $I' = 6870 \pm 70$ fm^2; $I = 7050 \pm 70$ fm^2; and $s_0 = 17.05 \pm 0.28$. (auth) (Netherlands)

1583 (UCRL-74013) STUDIES CONCERNING NUCLEAR COEXISTENCE IN ^{115}In. Meyer, R. A.; Struble, G. L. (California Univ., Livermore. Lawrence Livermore Lab.). 5 Jul 1972. 3p. (CONF-720932-1). Dep. NTIS.

From International conference on nuclear moments and nuclear structure; Osaka, Japan (4 Sep 1972).

Precise energies and intensities of γ rays emitted in the decay of ^{115}Cd were measured using a Compton suppression spectrometer and Ge(Li) detectors. Three new levels in ^{115}In were found. Theoretical conversion coefficients were used to extract B(E2) values for the 35-keV transition and inconsistent results were found. Possible explanations for the results are discussed. (J.W.R.)

1584 (UUIP-762) CONFIRMATION OF A 6.6 keV TRANSITION IN ^{129}Cs. Hoegberg, S. (Uppsala Univ. (Sweden). Inst. of Physics). Feb 1972. 7p. Dep. NTIS (U. S. Sales Only).

The existence of a reported low-energy transition in ^{129}Cs has been confirmed. The energy of the transition has been determined to be 6.551 ± 0.004 keV and an E2 content of more than 30% was established. (auth) (Sweden)

1585 (UUIP-779) NUCLEAR SPINS OF NEUTRON-DEFICIENT PROMETHIUM, SAMARIUM, AND GADOLINIUM ISOTOPES. Ekstroem, C.; Ingelman, S.; Olsmats, M.; Wannberg, B. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 23p. Dep. NTIS (U. S. Sales Only).

Spin measurements have been performed on some neutron-deficient promethium, samarium, and gadolinium isotopes using the conventional atomic-beam magnetic resonance method. The investigated nuclei appear close to the shell closure at neutron number N = 82, and the experimental results are easily interpreted on the basis of the spherical shell model. (auth) (Sweden)

1586 (UUIP-780) NUCLEAR SPINS OF NEUTRON-DEFICIENT PRASEODYMIUM AND NEODYMIUM ISOTOPES. Ekstroem, C.; Ingelman, S.; Olsmats, M.; Wannberg, B.; Andersson, G.; Rosen, A. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 30p. Dep. NTIS (U. S. Sales Only).

The atomic-beam magnetic resonance method has been used in spin measurements on some neutron-deficient praseodymium and neodymium isotopes. The results are: ^{133}Pr (7.5 min) I = 5/2, ^{134}Pr (18.5 min) I = 2, ^{135}Pr (24 min) I = 3/2, ^{136}Pr (13.5 min) I = 2, ^{137}Pr (76.6 min) I = 5/2, ^{138m}Pr (2.0 h) I = 7, ^{139}Pr (4.5 h) I = 5/2, ^{140}Pr (3.4 min) I = 1, ^{134}Nd (8 min) I = 0, ^{135}Nd (15 min) I = 9/2, ^{136}Nd (55 min) I = 0, ^{137}Nd (37 min) I = 1/2, ^{138}Nd (5.2 h) I = 0, ^{139}Nd (29.7 min) I = 3/2, ^{139m}Nd (5.5 h) I = 0, ^{140}Nd (3.38 d) I = 0. The spin values of nuclei in the vicinity of the N = 82 shell closure are in agreement with shell model predictions. In order to explain the nuclear spins of the neutron-deficient isotopes far from the beta stability line a deformed nuclear shape has to be assumed. (auth) (Sweden)

1587 DIRECTIONAL CORRELATION AND MULTIPOLE MIXING OF GAMMA TRANSITIONS IN ^{134}Ba AND ^{102}Ru. Singh, Balraj. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

Directional correlation experiments have been performed on selected cascades of gamma transitions in ^{134}Ba and ^{102}Ru. The experimental arrangement employed a 10 cc cylindrical Ge(Li) detector and two 7.5 cm × 7.5 cm cylindrical NaI(Tl) counters which were coupled to two separate fast coincidence systems and two halves of a 4096-channel pulse height analyser. The data on double and triple cascades were analyzed to provide information on the spins of the nuclear levels and the multipolarities of the associated gamma transitions. The correlation measurements of the 1038-605 keV, 563-605 keV, and 569-795 keV cascades in the ^{134}Ba nucleus yielded the spin of the 1643-keV level

and the multipole mixing of the 1038, 563, and 569 keV transitions. The results were compared with the conversion electron measurements. In the case of the ^{102}Ru nucleus, a spectroscopic study was carried out on the decay of ^{102}Rh giving a considerably revised and consistent level scheme. The spins of the levels at 944, 1581, 1837, 1873, 2037, 2219 and 2261 keV and the E2/M1 ratios for the 418.8, 627.8, 680.6, 739.2, 766.7, 1046.5, 1106.1, 1112.9, 1158.0 and 1562.0 keV transitions were deduced from directional correlation measurements on sixteen cascades. The experimental values of the square of the multipole mixing parameter "δ" have been compared with the theoretical values obtained from the collective model. The deduced α_K (electron conversion coefficients) for a few selected transitions are compared with the measured values. (Diss. Abstr. Int., B)

1588 ELECTRON CAPTURE TO POSITRON EMISSION RATIOS FOR ^{140}Pr, ^{141}Nd, AND ^{143}Sm. Evans, Jerry Lynn. Auburn, Ala.; Auburn Univ. (1972). 62p. University Microfilms Order No. 72-19,034.

Thesis.

The nuclides ^{140}Pr, ^{141}Nd, and ^{143}Sm decay both by positron emission and electron capture. These nuclides were produced by the (n,2n) reaction using energetic neutrons produced by the ^{7}Li(d,n)^{8}Be reaction with Auburn University's 3-MeV Dynamitron accelerator. A thin window NaI detector was used to count the K x-rays and .511 MeV annihilation radiation. The efficiency of the detector was determined theoretically in the x-ray region and experimentally at .511 MeV with a ^{22}Na source. Corrections were made where necessary for self-absorption, fluorescence yield, escape peak, and differences in length and time of counting. The total electron capture was determined by use of the K/total ratio. The K-capture to positron emission ratio and the percentage of total decay by positron emission were determined. The percentages of positron emission for ^{140}Pr, ^{141}Nd, and ^{143}Sm were 56.3 ± 7.0, $2.44^{+}_{-}{}^{14}_{8}$, and $39.4^{+}_{-}{}^{8}_{1}$. (Diss. Abstr. Int., B)

1589 LEVELS OF ^{130}Xe EXCITED DURING β DECAY OF ^{130}I AND ^{130*}I. Bakiev, S. A.; Baskova, K. A.; Vasil'ev, S. S.; (and others). (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 115-24(Jan 1972). (In Russian).

The level scheme of ^{130}Xe was investigated through the study of the radioisotope ^{130}I ($T_{½}$ = 12.5 hr) and ^{130*}I ($T_{½}$ = 9.2 min). The γ−γ coincidence spectrum and angular correlation of γ quanta were measured. The decay scheme is discussed. (tr-auth)

1590 STRUCTURE OF LEVELS WITH HIGH SPIN FOR THE NUCLEI ^{144}Sm, ^{146}Gd, ^{143}Sm, AND ^{145}Gd. Peker, L. K.; Ride, Kh.; Sergeev, V. O.; Sulkovskii, Z.; Kovnatskii, Ya. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 111-14(Jan 1972). (In Russian).

An analysis of experimental data on high-spin levels of the near-magic nuclei ^{143,144}Sm, ^{145,146}Gd was performed. Spins, parity, and possible configurations were assigned to a series of levels. (tr-auth)

1591 INTERNAL CONVERSION AT THE HIGHER SHELLS IN THE DECAY OF ^{113}In* (100 MIN). Koever, A. (Inst. of Nuclear Research, Debrecen, Hungary); Berenyi, D.; Csongor, J. Z. Phys.; 254: No. 5, 418-23(1972).

The ratios of the conversion coefficients at the higher shells and subshells were measured in the 391.7-keV isomeric transition of ^{113}In. On the basis of a computer analysis of the L-subshell conversion lines it can be stated that the transition has an M4 character and the most probable value of the E5 admixture is zero. The L/M and M/N conversion ratios show a good agreement with the recent calculations of Hager and Seltzer and Dragoun et al. (3 figures, 2 tables) (auth)

1592 PHOTONEUTRON CROSS SECTIONS FOR TIN ISOTOPES WITH A = 114, 116, 117, 119, 122, AND 124. Sorokin, Yu. I.; Khrushchev, V. A.; Yur'ev, B. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 180-3(Jan 1972). (In Russian).

Neutron yield curves were determined using a neutron detector with BF_3 counters. Using these data, photoneutron cross sections were measured for the isotopes ^{114}Sn, ^{116}Sn, ^{117}Sn, ^{119}Sn, ^{122}Sn, and ^{124}Sn from the threshold to 27 MeV. The results obtained were compared with existing calculated data. Remarkably high cross sections were noted in the region above 20 MeV over the values obtained from the particle-hole model allowing for isospin of the dipole states. (tr-auth)

1593 DECAY OF ^{147}Gd AND THE LEVEL SCHEME FOR ^{147}Eu. Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Tikhonov, N. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 76-88(Jan 1972). (In Russian).

γ ray spectra, γ−γ coincidences, and internal conversion electrons were measured for the decay of ^{147}Gd. The decay scheme of ^{147}Gd was constructed, and attempts were made to attribute the observed levels of ^{147}Eu to various forms of excitation: single-particle, three-particle, and collective. (tr-auth)

1594 EXCITATION OF NUCLEAR LEVELS OF ^{104}Pd AND ^{106}Pd IN REACTIONS (α,xn). Grigor'ev, E. P.; Zolotavin, A. V.; Ride, Kh.; Sergeev, V. O. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 65-70(Jan 1972). (In Russian).

The γ ray spectra which arose from the reactions ^{104}Ru(α,2n)^{106}Pd and ^{104}Ru(α,4n)^{104}Pd were studied using an α particle beam with energies of from 26 to 43 MeV. The following levels were established: 6^+ (2,076.1 keV); 8^+ (2,962.1 and 10^+ (3,532.4) in ^{106}Pd and 6^+ (2,249) and 8^+ (3,219) in ^{104}Pd, which are related to quasi-rotational bands in basic states. (tr-auth)

1595 DECAY OF THE NATURAL NUCLIDE ^{138}La($T_{½}$ = 1.27×10^{11} YEARS). Marsol, Claire; Armanet, Francois; Adrisson, Gerard (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. B; 274: No. 14, 904-6(5 Apr 1972). (In French).

The gamma radiation associated with the decay of ^{138}La was measured in order to obtain the energy of the emitted radiation and the value of the electron capture/β^- branching ratio. (France)

1596 OPTICAL DETERMINATION OF THE NUCLEAR MOMENTS OF ^{137}La. Fischer, W.; Huehnermann, H.; Mandrek, K. (Philipps Univ., Marburg, Ger.). Z. Phys.; 254: No. 2, 127-32(1972).

By using the reactor-produced lanthanum isotope $^{137}_{57}$La, the hyperfine structure (hfs) of the transitions La I, $5d^2$ 6p z $^4G^0_{11/2}$ − $5d^2$ 6s a $^4F_{9/2}$, λ = 6250 Å and La I, $5d^2$ 6p z $^2H^0_{11/2}$ − $5d^2$ 6s a $^2G_{9/2}$, λ = 6266 Å were measured by means of a Fabry−Pérot interferometer. The nuclear spin I (^{137}La) = 7/2, already theoretically estimated by earlier authors, was confirmed. The nuclear magnetic dipole moment $\mu_I(^{137}La) = +2.690(6)$ n.m. and the electric quadrupole moment $Q(^{137}La) = +0.26(8) \cdot 10^{-24}$ cm^2 were determined from the ratios of the hfs interaction constants A and B of ^{137}La and the natural ^{139}La. (auth)

1597 ISOMERIC STATE IN ^{134}Nd. Parkinson, D. G.; Fraser, I. A.; Lisle, J. C.; Willmott, J. C. (Univ. of Manchester, Eng.). Nucl. Phys.; A194: No. 2, 443-8(1972).

States of ^{134}Nd have been excited by the reaction ^{118}Sn(^{20}Ne,4n), and the first four members of a band based on the ground state have been identified. An isomeric state at 2294 keV with a half-life of 410 μs has been observed. This is found to decay to the 8^+ member of the ground-state band by an E1 transition which is hindered by 10^{10} and is shown to possess $J^\pi = 8^-$. A weak M2 transition with a hindrance of 10^7 is observed to the 6^+ member. Isomerism involving an 8^- state is shown to be a common feature of N = 74 isotones, and a possible two-neutron quasiparticle configuration is identified. (auth)

1598 TABLE OF GAMMA RAYS FROM FISSION PRODUCTS. Blachot, J.; de Tourreil, R. (CEN, Grenoble, France). J. Radioanal. Chem.; 11: No. 2, 351-435(Aug 1972).

Data for all neutron-rich nuclides (fission products) from ^{70}Zn to ^{170}Tm are included. This table is derived from a computer listing. Included are: γ rays ordered by energy in keV; relative intensities of the γ rays; name of the isotope and mass number (F means ground state, M isomer); half-life (S = second, M = minute, H = hour, J = day, A = year). The literature was surveyed up to January 1971. (M.C.G.)

1599 INTERNAL CONVERSION AND GAMMA-RAY STUDIES OF THE DECAY OF ^{101}Pd. Nyman, B.; Sieniawski, J.; Pettersson, H. (Univ. of Uppsala). Phys. Scr.; 5: No. 1-2, 13-21 (1972).

The decay of 8.47-h ^{101}Pd was studied by use of large-volume Ge(Li) detectors and a high-resolution 50-cm-radius double-focusing beta-ray spectrometer. By combining measured internal conversion and gamma-ray intensities multipolarities for all prominent transitions were deduced from the conversion coefficients. Based on the assigned multipolarities a consistent level scheme of ^{101}Rh has been constructed where spin−parity assignments are given for all but one level. (auth) (Sweden)

1600 SIGN OF THE MULTIPLE COULOMB EXCITATION INTERFERENCE TERM AND THE STATIC QUADRUPOLE MOMENT OF THE FIRST 2^+ STATE OF ^{114}Cd. Larsen, R. D.; Thomson, J. A.; Kerr, R. G.; Scharenberg, R. P.; Lutz, W. R. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A195: No. 1, 119-28(1972).

A Coulomb excitation experiment was performed on the first 2^+ state of ^{114}Cd. Thin foils of enriched ^{114}CdO were bombarded by 50-MeV ^{32}S ions. The relative excitation probabilities of the first 2^+ state were measured at backward and forward projectile scattering angles. Particle-γ coincidences were used to identify the inelastic events. The data were analyzed with the aid of the Winther−De Boer multiple Coulomb excitation program. The projec-

tile and its bombarding energy were chosen to minimize the effect of the experiment of Coulomb excitation of the first 2^+ state via the second 2^+ state. By comparing the results of this work with the results of the high excitation probability experiment of Berant et al., it was possible to deduce that the sign of the interference term due to Coulomb excitation of the first 2^+ state via the second 2^+ state is positive. The static quadrupole moment of the first 2^+ state was determined to be $Q_{2^+} = -0.35 \pm 0.07$ b. (auth)

1601 PROTON–NEUTRON-HOLE STATES IN ^{132}Sb POPULATED IN THE β-DECAY OF THE DOUBLY CLOSED SHELL NUCLEUS ^{132}Sn. Kerek, A.; Holm, G. B.; Carle, P.; McDonald, J. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A195: No. 1, 159-76(1972).

The β-decay of the doubly closed ^{132}Sn nuclide and the accompanying γ-rays in the pn^{-1} nucleus $^{132}_{51}Sb_{81}$ were studied using Ge(Li) and anthracene detectors. The tin samples were produced using the OSIRIS on-line isotope separator for fission fragments of ^{235}U. A half-life of 40 ± 1 sec has been determined for the ground state of ^{132}Sn which decays by a single β-transition to a 1^+ level at 1324.3 keV in ^{132}Sb. This level is de-excited by γ-transitions of different energies. The first excited state (3^+) of ^{132}Sb occurs at 85.5 keV. Using a delayed-coincidence technique with fast timing, the half-life of this 3^+ state has been measured to be $T_{\frac{1}{2}} = 14.8 \pm 1.8$ ns. The B(M1) value associated with this transition to the 4^+ ground state is compared with the calculated transition probability. The states observed in ^{132}Sb are interpreted in terms of different pn^{-1} configurations and calculations have been made using a δ-force interaction between the odd proton and the odd-neutron hole. The reduced transition probability for the 40 sec β-decay of ^{132}Sn is compared with the calculated B(GT) value. (auth)

1602 EXCITATION OF ISOMERIC ACTIVITIES IN ^{131,133,135}Ba BY 14.8 MeV NEUTRONS. Rurarz, E. (Inst. of Nuclear Research, Swierk, Poland); Haratym, Z.; Kozlowski, T.; Oblozinsky, P. Acta Phys. Pol., B3: No. 5, 637-41(1972).

The cross sections for the production of isomeric states in ^{131,133,135}Ba through the (n,2n) reaction using 14.8-MeV neutrons are given. Estimates were obtained for isomeric ratios using the Huizenga and Vandenbosch method and the Gilbert and Cameron level density model. (auth)

1603 DECAY OF ^{138}Xe. Monnand, E.; Brissot, R.; Carraz, L. C.; (and others) (CEN, Grenoble, France). Nucl. Phys.; A195: No. 1, 192-206(1972). (In French).

The β- and γ-ray decay of the fission product ^{138}Xe has been studied using the ARIEL on-line isotope separator. The γ-rays have been studied with Ge(Li) detectors both in singles and coincidence between 3 and 2700 keV. The low-energy internal conversion and Auger L spectrum has been recorded with a double-focussing magnetic β-spectrometer. A tentative level scheme is given with a possible shell-model interpretation. (auth)

1604 MEASUREMENTS OF THE ELASTIC SCATTERING CROSS-SECTION OF ALPHA PARTICLES ON THE HEAVY AND MEDIUM WEIGHT NUCLEI IN THE VICINITY OF THE COULOMB BARRIER IN A WIDE ANGULAR RANGE. Karcz, W. (Jagellonian Univ., Krakow); Kluska, I.; Sanok, Z.; (and others). Acta Phys. Pol.; B3: No. 4, 525-30(1972).

The measurements of differential cross sections of elastically scattered alpha particles with energies 23.5 and 27.7 MeV on Nb, Pd, Ag, In, Sn, Ta, Pt, Au, Pb, and Bi targets, made of natural elements, were performed at a wide range of angles. The experimental procedure and the results are presented. It was observed that the oscillatory structure of $\sigma(\theta)/\sigma_R$ disappears continuously when energy is lowered from higher to lower values and approaches the Coulomb barrier. The slope of $\sigma(\theta)/\sigma_R$ and the cross-section values, obtained at backward angles, varies more rapidly with energy in the vicinity of the Coulomb barrier. (auth)

1605 MEASUREMENTS ON ^{117m}Sn. John, P.; Reuse, B.; Schneider, H. (Justus Liebig Univ., Giessen, Ger.). Z. Phys.; 254: No. 2, 142-7(1972).

By combination of a differential and an integral measurement of perturbed angular correlations the sign and the magnitude of the g-factor of the 158.6 keV level in ^{117}Sn which is populated and depopulated by a 156.0 keV (M4)–158.6 keV (M1)–γ-γ-cascade was determined to be $g = +0.45^{+0.15}_{-0.30}$. An investigation of its half-life yielded $T_{\frac{1}{2}} = 0.279 \pm 0.009$ nsec. The total conversion coefficient of the M4-transition was found to be 46.3 ± 1.8. (auth)

1606 GAMMA DECAY OF ^{93}Mo STATES FROM ^{92}Mo(d,pγ) AND ^{93}Tc β-DECAY. Duennweber. W.; Borcea, C.; von Brentano, P.; Grosse, E. (Max-Planck-Inst. fuer Kernphysik, Heidelberg). Z. Phys.; 254: No. 2, 133-41(1972).

The decay scheme of the fragmented single neutron states of ^{93}Mo up to 3.2 MeV excitation energy is obtained from a ^{92}Mo(d,pγ)^{93}Mo coincidence experiment. The total γ-spectrum from ^{92}Mo + d shows additional strong γ-decays following the β-decay of ^{93}Tc produced by the (d,n) reaction. The decay scheme is discussed in the frame of the particle-core coupling model. The important role of 2^+ core excited components in E2 and M1 transitions between states with different angular momentum of the single particle component is pointed out. (auth)

1607 EVIDENCE FOR PARTICLE-CORE COUPLING IN THE ^{125}Te NUCLEUS. Kerek, A.; Kownacki, J.; Marelius, A.; Phil, J. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A194: No. 1, 64-80(1972).

The high-spin states of ^{125}Te have been investigated using the ^{124}Sn (α,3nγ) reaction and the in-beam technique. Besides low-spin levels observed in the radioactive decay, the high-spin positive- and negative-parity bands have been established. As a possible explanation of the nature of the excited states in ^{125}Te the idea of the of the odd-neutron (hole)-core coupling is discussed. (auth)

1608 STUDY OF THE ^{113}In(^{3}He,d)^{114}Sn REACTION AT 37.7 MeV. Cage, M. E.; Kunz, P. D.; Johnson, R. R.; Lind, D. A. (Univ. of Colorado, Boulder). J. Phys., A (London); 5: No. 10, 1529-36(Oct 1972).

The proton particle-hole states of ^{114}Sn were studied by the ^{113}In(^{3}He,d)^{114}Sn reaction at 37.7 MeV. A ^{113}In(^{3}He,^{3}He)^{113}In elastic scattering experiment provided ^{3}He optical model parameters for the DWBA analysis. The ground state and seven excited states of ^{114}Sn yielded deuteron groups which could be analyzed in terms of angular momentum transfers of l = 2 or l = 4. These transferred protons are believed to occupy $2d_{\frac{5}{2}}$ or $1g_{\frac{7}{2}}$ orbitals and to couple with a $1g_{\frac{9}{2}}$ proton hole. Partial strengths extracted from the angular distributions are consistent with the results obtained on ^{115}In(^{3}He,d)^{116}Sn by Biggerstaff et al. (Phys. Lett. 25B, 273, 1967), but not with those of Shoup et al. (Nucl. Phys. A, 135, 689, 1969). (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 1525, 1539, 1581, 1598, 1604, 1625, and 1640.

1609 (FRNC-TH-239) STUDY OF THE DEFORMATION OF ^{152}Sm BY SCATTERING OF A BEAM OF POLARIZED PROTONS. Barbier, Marie-Paule (Paris Univ. (France)). 1971. 55p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The elastic and inelastic scattering of a 24.55-MeV beam of polarized protons by ^{152}Sm was studied. The angular distribution of the cross sections and the asymmetries of the 0^+, 2^+ and 4^+ levels of the ground state rotational band were studied. The elastic scattering is theoretically studied using the optical model and the inelastic scattering is theoretically studied using the coupled equation method. The values obtained for the deformation parameters are: $\beta_4 = 0.050 \pm 0.015$, $\beta_2 = 0.25 \pm 0.02$. These values are identical to those determined using a 50 MeV beam of α particles. It was not possible to accurately determine the form of the spin-orbit potential, but only to confirm that it must be deformed. 'France)

1610 (JINR-P3-6611) MAGNETIC MOMENTS OF ^{168}Er STATES EXCITED BY NEUTRON CAPTURE. Alfimenkov, V. P.; Zhukov, G. P.; Zimin, G. N.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

Magnetic moments of the neutron resonances in ^{167}Er at 0.460 and 0.584 eV were measured using the technique of neutron transmission through the polarized target. The following values are obtained $\mu_J(0.460) = (0.9 \pm 0.4)\mu_N$ and $\mu_J(0.584) = (1.8 \pm 0.9)\mu_N$. (auth)

1611 (UUIP-761) RELATIVE INTERNAL CONVERSION ELECTRON INTENSITIES OF THE 113 keV TRANSITION IN ^{177}Hf. Hoegberg, S.; Jadrny, R.; Karlsson, S.-E.; Malmsten, G.; Nilsson, O. (Uppsala Univ. (Sweden). Inst. of Physics). Feb 1972. 14p. Dep. NTIS (U. S. Sales Only).

The intensities of the internal conversion lines of the 113 keV M1 + E2 transition in ^{177}Hf have been measured. From comparison with theoretical conversion coefficients the transition has been found to be (95.2 ± 0.5)% E2 corresponding to $|\delta| = 4.5 \pm 0.3$. The theoretical L_I and M_I conversion coefficients used in the comparison have been increased by 5% according to the result that for pure E2 transitions in the deformed region the L_I/L_{II}, L_I/L_{III}, M_I/M_{II} and M_I/M_{III} theoretical ratios are too low (~5%). Moreover, the present result indicates that the L_{II}/L_{III} and M_{II}/M_{III} ratios obtained from the tabulations by Hager and Seltzer

and from the computer program by Pauli are too high (1–2%). (auth) (Sweden)

1612 (UUIP-778) HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF ^{161}Er AND ^{163}Er. Ekstroem, C.; Ingelman, S.; Olsmats, M.; Wannberg, B. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 24p. Dep. NTIS (U. S. Sales Only).

The hyperfine interaction constants in the atomic ground state of ^{161}Er and ^{163}Er have been measured using the atomic-beam magnetic resonance method. The results are for ^{161}Er: a = −183.8(1.4) MHz, b = 1738(10) MHz and for ^{163}Er: a = 167(7) MHz, b = −3275(130) MHz. The nuclear moments are evaluated by comparison with ^{167}Er. The resulting moments are for ^{161}Er: μ_I = −0.369(4) n.m., Q = 1.20(8) barns, and for ^{163}Er: μ_I = 0.56(2) n.m., Q = 2.2(2) barns. The dipole moments are corrected for diamagnetic shielding and the uncertainties in the quadrupole moments include that introduced by the Sternheimer effect. (auth) (Sweden)

1613 ENERGY LEVELS OF ^{152}Sm POPULATED IN THE DECAY OF THE $J^\pi = 0^-$ ISOMER OF ^{152}Eu. Ardisson, Gerard; Armanet, Francois; Al Foudi, Abdallah. Compt. Rend., Ser. B; 274: No. 26, 1436-9(26 Jun 1972). (In French).

The decay of ^{152m}Eu was studied using a Ge(Li) detector. 32 γ transitions were observed, 14 of them for the first time. Most of them were attributed to ^{152}Gd and ^{152}Sm. A new level at 1002.7 keV is proposed for ^{152}Sm; the 810.3 and 1130.3 keV levels were also populated. (France)

1614 PROPERTIES OF β- AND γ-VIBRATIONAL LEVELS. Hamilton, J. H. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 17-55(Jan 1972). (In Russian).

This review article presents data on low-lying levels, ground states, relative intensities of γ rays, M-1 transitions, and relative branching in connection with the nuclei ^{152}Sm, ^{154}Gd, and ^{156}Gd. Data on various states of ^{160}Dy, ^{178}Ta, ^{178}Hf, ^{180}Hf, and ^{174}Hf are tabulated and discussed. 76 references. (K.S.W.)

1615 SUPPLEMENT TO THE ^{169}Lu DECAY SCHEME. Dzhelepov, B. S.; Medvedev, A. I.; Ter-Nersesyants, V. E.; Shestopalova, S. A. (All-Union Scientific-Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 56-64(Jan 1972). (In Russian).

Internal conversion electron measurements were conducted on ^{169}Lu at the transition intervals 450 to 550, 1,680 to 1,765, and 2,170 to 2,370 keV. The decay scheme of ^{169}Lu earlier proposed by the authors has been revised and corrected on the basis of all available data. More accurate values of energy levels, lg ft, are presented for the ^{169}Lu decay scheme. (tr-auth)

1616 NEW DATA ON THE SPECTRUM OF CONVERSION ELECTRONS OF ^{172}Lu; CONVERSION TRANSITION COEFFICIENTS. Balalaev, V. A.; Dzhelepov, B. S.; Medvedev, A. I.; (and others) (All-Union Scientific-Research Inst. of Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 71-5(Jan 1972). (In Russian).

Refined measurements of conversion electrons of ^{172}Lu are given in the energy region $E_{e^-} > 300$ keV. The relative intensities of K-conversion lines of 96 transitions are tabulated; 32 of these for the first time. Values of α_K were determined for a series of the transitions. (tr-auth)

1617 RADIATION CONSTANTS OF ^{170}Tm. Dzhelepov, B. S. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 99-110(Jan 1972). (In Russian).

Constants for two low bands of ^{170}Tm were determined from measurements of the magnetic and electric moments, B(E2)↑, the γ ray spectra and conversion electrons. Levels of the two bands under consideration were: the bands of the basic state of ^{170}Tm with $K^\pi = 1^-$ and bands with $K^\pi = 0^-$, based on the 149,721 keV state. Only two low states of ^{170}Tm possess a half-life greater than 1 nsec. (K.S.W.)

1618 DIFFERENTIAL CROSS SECTIONS AND ANGULAR DISTRIBUTIONS OF γ-RAYS FROM (n,n'γ) REACTION ON ^{141}Pr AND ^{165}Ho. Andreev, E. A.; Sit'ko, S. P.; Shevchenko, V. A. (Kiev State Univ.). Yadern. Fiz.; 15: No. 5, 856-9(May 1972). (In Russian).

The angular distributions and differential cross sections of γ rays from (n,n'γ) reactions on ^{141}Pr and ^{165}Ho were measured. Some new γ transitions from the excited states of Pr and Ho were found, in the region of excitation energies more than 1.0 MeV. The spins of the corresponding levels of these nuclei were determined by the comparison of the experimental data and theoretical calculations based on Satchler theory. (auth)

1619 MOESSBAUER STUDIES AND NUCLEAR QUADRUPOLE MOMENTS OF $^{186\ 188\ 189\ 190}$Os. Wagner, Friedrich E. (Technische Univ., Munich); Spieler, Helmut; Kucheida, Dieter; Kienle, P.; Waeppling, R. Z. Phys.; 254: No. 2, 112-26(1972).

Moessbauer transmission experiments with the 137-, 155-, 69-, and 187-keV gamma rays of ^{186,188,189,190}Os, respectively, yielded the electric quadrupole splitting of these gamma resonance lines in OsO_2 and OsP_2. From the results the following ratios of quadrupole moments were derived: $Q_{2^+}(^{186}\text{Os}, 137\text{ keV}) : Q_{2^+}(^{188}\text{Os}, 155\text{ keV}) : Q_{2^+}(^{190}\text{Os}, 187\text{ keV}) : Q_{3/2}(^{189}\text{Os}, \text{g.s.}) = (+1.100 \pm 0.020) : 1.0 : (+0.863 \pm 0.051) : (-0.586 \pm 0.011)$ and $Q_{3/2}(^{189}\text{Os}, 69\text{ keV}) / Q_{3/2}(^{189}\text{Os}, \text{g.s.}) = -0.735 \pm 0.012$. The ratios for ^{186,188,190}Os are, within their limits of error, in agreement with the expectation of the rotational model; this agreement indicates that the pairing-plus-quadrupole model calculations of Kumar and Baranger predict too rapid a transition from rotational to vibrational nuclei. Applying this argument to ^{186}Os in particular and using the measured ratios, one obtains a set of values for the quadrupole moments themselves, namely $Q_{2^+}(^{186}\text{Os}) = -(1.50 \pm 0.10)$ b, $Q_{2^+}(^{188}\text{Os}) = -(1.36 \pm 0.09)$ b, $Q_{2^+}(^{190}\text{Os}) = -(1.18 \pm 0.08)$ b, $Q_{3/2}(^{189}\text{Os}) = +(0.80 \pm 0.06)$ b, and $Q_{3/2}(^{189}\text{Os}) = -(0.59 \pm 0.05)$ b. For the electric field gradient at Os nuclei in Re metal a value of $V_{zz} = -(3.3 \pm 0.6) \cdot 10^{17}$ V/cm^2 was found. A measurement with a magnetically split source yielded $\delta = +0.685 \pm 0.025$ for the E2/M1 mixing parameter of the 69-keV transition of ^{189}Os, $g_{3/2}/g_{1/2} = 0.895 \pm 0.006$ for the ratio of the g factors of the 69-keV state and the ground state, and $H_i = -(1135 \pm 20)$ kOe for the hyperfine field at Os nuclei in an iron matrix. (auth)

1620 LEVEL SCHEME OF ^{176}Lu INVESTIGATED BY (n,γ) AND (n,e) REACTIONS. Balodis, M. K. (Inst. of Physics, Riga); Tambergs, J. J.; Alksnis, K. J.; (and others). Nucl. Phys.; A194: No. 2, 305-28(1972).

The excited levels of ^{176}Lu have been studied using the conversion electron and γ-spectra from slow neutron capture in ^{175}Lu measured with the β-spectrograph at Riga and with the diffraction spectrometer at Risø. The proposed level scheme contains the rotational bands with the following lowest levels E, $I^\pi K$ and Nilsson configurations: 126 keV, 1^-0, $p^{}_{7/2}{}^+[404] - n^{}_{7/2}{}^-[514]$; 198 keV, 1^+1, $p^{}_{7/2}{}^+[404] - n^{}_{9/2}{}^+[624]$; 342 keV, 1^+1, $p^{}_{9/2}{}^-[514] - n^{}_{7/2}{}^-[514]$; 390 keV, 1^-1, $p^{}_{7/2}{}^+[404] - 5^-_{/2}[512]$; 638 keV, 4^+4, $p^{}_{1/2}{}^-[541] + n^{}_{7/2}{}^-[514]$; 641 keV, 1^-1, $p^{}_{5/2}{}^+[402] - n^{}_{7/2}{}^-[514]$; 660 keV, 5^+5, $p^{}_{3/2}{}^-[514] + n^{}_{1/2}{}^-[510]$; 662 keV, 3^-3, $p^{}_{7/2}{}^+[404] - n^{}_{1/2}{}^-[510]$; 726 keV, 4^-4, $p^{}_{1/2}{}^+[411] + n^{}_{7/2}{}^-[514]$. The bands with 0 keV, 7^-7, $p^{}_{7/2}{}^+[404] + n^{}_{1/2}{}^-[514]$ and 404 keV, 8^+8, $p^{}_{7/2}{}^+[404] + n^{}_{9/2}{}^+[624]$, can be discussed only on the basis of earlier (d,p) and (d,d') reaction data. (auth)

1621 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF ^{161}Er AND ^{163}Er. Ekstroem, C.; Ingelman, S.; Olsmats, M.; Wannberg, B. (Univ. of Uppsala). Nucl. Phys.; A194: No. 2, 237-48(1972).

The hyperfine interaction constants in the atomic ground state of ^{161}Er and ^{163}Er have been measured using the atomic-beam magnetic resonance method. The results are, for ^{161}Er: a = −183.8(1.4) MHz, b = −1738(10) MHz, and for ^{163}Er: a = 167(7) MHz, b = −3275(130) MHz. The nuclear moments are evaluated by comparison with ^{167}Er. The resulting moments are, for ^{161}Er: μ_I = −0.369(5) n.m., Q = 1.20(9) b, and for ^{163}Er: μ_I = 0.56(3) n.m., Q = 2.2(2) b. The dipole moments are corrected for diamagnetic shielding and the uncertainties in the quadrupole moments include the error introduced by the Sternheimer effect. (auth)

1622 RELATIVE INTERNAL CONVERSION ELECTRON INTENSITIES OF THE 113 keV TRANSITION IN ^{177}Hf. Hoegberg, S.; Jadrny, R.; Karlsson, S.-E.; Malmsten, G.; Nilsson, Oe. (Univ. of Uppsala). Z. Phys.; 254: No. 2, 89-97(1972).

The intensities of the internal conversion lines of the 113-keV M1 + E2 transition in ^{177}Hf were measured. From comparison with theoretical conversion coefficients the transition was found to be (95.2 ± 0.5)% E2 corresponding to $|\delta| = 4.5 \pm 0.3$. The theoretical L_I and M_I conversion coefficients used in the comparison were increased by 5% according to the result that for pure E2 transitions in the deformed region the L_I/L_{II}, L_I/L_{III}, M_I/M_{II}, and M_I/M_{III} theoretical ratios are too low (~5%). Moreover, the present result indicates that the L_{II}/L_{III} and M_{II}/M_{III} ratios obtained from the tabulations by Hager and Seltzer and from the computer program by Pauli are too high (1 to 2%). (2 figures, 2 tables) (auth)

1623 NEUTRON CAPTURE CROSS SECTIONS IN THE keV REGION FOR ^{154}Sm, ^{160}Gd, ^{164}Dy, AND ^{165}Ho. Fawcett, L. R. Jr.; Furr, A. Keith; Lindsay, J. G. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Nucl. Sci. Eng.; 49: No. 3, 317-29(Nov 1972).

Neutron capture cross sections for ^{154}Sm, ^{160}Gd, ^{164}Dy, and ^{165}Ho (ground state) have been investigated in the energy range from 5 to 160 keV. Capture cross section data in this energy region that are currently available for ^{165}Ho varies by approxi-

mately a factor of two between different workers and for ^{154}Sm, ^{160}Gd, and ^{164}Dy little or no previously published data are available in this energy range. The present work represents an attempt to remove some of the uncertainty in the case of ^{165}Ho and to provide original data for the other three isotopes over the 5 to 160 keV region. This work was done by activation of metal samples of the above mentioned rare earths and counting the decay products with a well type plastic scintillator. Samples were activated by neutrons generated by the ^{7}Li(p,n)^{7}Be reaction with the samples being placed at 90 deg with respect to the neutron target. The 0.820 b capture cross section of ^{127}I at 25 keV was used as the standard for normalization along with thermal neutron capture cross sections of the isotopes. From the experimental cross section curves the γ-ray strength functions, the s-wave neutron strength functions, and the p-wave neutron strength functions were determined. These parameters are the first to be determined for samarium and dysprosium over an energy region this broad while for gadolinium, only one other comparable set exists. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 1539, 1581, 1604, 1619, and 1646.

1624 EXCITATION FUNCTION FOR THE REACTIONS ^{197}Au + d. Khrisanfov, Yu. V.; Padalko, V. Yu.; Zarubin, P. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 641-3(Mar 1972). (In Russian).

The excitation functions for ^{197}Au were studied for the (d,p), (d,2n), and (d,t) reactions. Deuteron energies from those with minimal yield up to 12 MeV were included in this study. (tr-auth)

1625 (FRNC-TH-253) NEUTRON-DEFICIENT EVEN Pb ISOTOPES. Pautrat, Michele (Paris Univ., Orsay (France)). 1972. 76p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The results of two series of experiments which enabled the level schemes of ^{202}Pb, ^{200}Pb, ^{198}Pb, ^{196}Pb, and ^{194}Pb to be established are presented: investigations of the decay of ^{202}Bi, ^{200}Bi, and ^{198}Bi (these sources being produced by the bombardment of a natural Pb source with protons); nuclear reactions induced by heavy ions: (^{12}C,4n) with ^{192}Os, ^{190}Os, and ^{188}Os, (^{16}O,4n) with ^{186}W, ^{184}W and ^{182}W, and (^{14}N, 5n) with ^{187}Re and ^{185}Re (at different energies between 65 and 97 MeV). The level schemes are compared with those derived from two theoretical models using a two quasi-particle approximation developed from the delta surface interaction or the Gaussian type central interaction. (France)

1626 (FRNC-TH-263) STUDY OF TWO-PROTON TRANSFER REACTIONS INDUCED BY HEAVY IONS (C, N, O, Ar) ON Bi. EFFECT OF THE NATURE OF THE PROJECTILE. Maison, Jeannine (Paris Univ., Orsay (France)). 1972. 55p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The angular distributions and the residual nucleus (^{211}At) recoil resulting from the bombardment of Bi targets with ^{12}C, ^{14}N, ^{16}O and ^{40}Ar projectiles were studied. Kinematic analysis enabled the mechanisms leading to the production of ^{211}At to be identified. At low energies (near to the Coulomb barrier), a two-proton transfer mechanism followed by a γ de-excitation process takes place (2p-γ-process). At higher energies, other two-charge transfer processes are possible (^{3}He-n), (α-2n). The bombardment of Tl targets with Ar ions led to the production of ^{211}At and ^{211}Rn (cross sections of the order of 1.5 mb). In the framework of the quasi-elastic transfer theory, the utilization of the experimental angular distributions in the center of mass system enabled the minimum distance of approach (r_0) associated with the maximum probability of obtaining a particular transfer to be obtained. The r_0 value calculated from these distances is approximately equal to 1.6 fm for the (2p-γ) mechanism with a ^{209}Bi target and C, N, or O projectiles. When Ar projectiles are used, this distance is about 1.47 fm. (France)

1627 (LYCEN-7226) ELECTROMAGNETIC PROPERTIES OF EVEN-EVEN PLATINUM NUCLEI. Berkes, I.; Rougny, R.; Meyer-Levy, Michele; Chery, R.; Daniere, J.; Lhersonneau, G.; Troncy, A. (Lyon Univ. (France). Institut de Physique Nucleaire). May 1972. 21p. (In French). Dep. NTIS (U. S. Sales Only).

The lifetimes of the first and second excited states in ^{194}Pt and ^{196}Pt were determined using delayed coincidence techniques; they are $\tau(2^+) = 50 \pm 5$ ps, $\tau(2^+) = 51 \pm 6$ ps for ^{194}Pt and $\tau(2^+) = 43.6 \pm 3.0$ ps, $\tau(2^+) = 52 \pm 5$ ps for ^{196}Pt. The transition probabilities for the $2^+ \rightarrow 0^+$ and $2^+ \rightarrow 2^+$ transitions decrease with the atomic mass-numbers. New lifetimes were used to reevaluate nuclear g-factors. Phenomenological anharmonic vibration model calculations are in agreement with the experimental quadrupole transition probabilities and nuclear g-factors. (France)

1628 LOW-LYING LEVELS OF ^{201}Hg FROM THE DECAY OF ^{201}Au. Pakkanen, A.; Helppi, H.; Komppa, T.; Puumalainen, P. (Univ. of Jyvaeskylae, Finland). Z. Phys.; 254: No. 2, 98-105(1972).

The decay of 26.4-min ^{201}Au was investigated using chemically separated sources and Ge(Li), Si(Li), plastic, and NaI(Tl) detectors in different singles and coincidence arrangements. The β-disintegration energy was measured to be 1.27 ± 0.10 MeV. Thirteen γ rays were observed to belong to this decay, and new levels at 543, 549.2, 552.8, 559.1, 605.7, 645.4, 732, and 1188 keV were established in ^{201}Hg, in addition to the three previously known excited states below 200 keV. (auth) (3 figures, 2 tables)

1629 PRECISION ANALYSIS OF ^{198}Au BETA SPECTRAL SHAPE. Nagarajan, T. (Univ. of Madras); Ravindranath, M.; Venkata Reddy, K. J. Phys., A (London): 5: No. 9, 1395-1403(Sep 1972).

The investigation of the 965-keV transition of ^{198}Au shows that the same data analyzed with the Fermi function taken from NBS tables and that from Dzhelepov and Zyrianova (corrected for finite size) differ by 3% in slope. With a shape factor $C(W) = k(1 + aW)$ the coefficient a has been determined to be -0.022 ± 0.011 using Bhalla and Rose tables [ORNL Report No. 3207 (1962)] with Buhring's screening correction [Nucl. Phys. 40; 472-88 (1963)] and the correct end point determined from the proper physical behavior of the shape factor in the neighborhood of the end-point energy. The use of this coefficient through the PBS method gives $\alpha_{412K} = (301 \pm 3)10^{-4}$ in agreement with theory as well as the recent very accurate IEC methods. This means that the disagreement of the PBS method with theory and other accurate methods arises mainly through the occurrence of a shape factor in the electron energy spectrum, and the use of the correct shape factor in the PBS method gives good agreement. (auth)

1630 MEASUREMENT OF E4 CROSS-OVER TRANSITION OF ^{204}Pb. Sugiyama, Kazusuke; Kotajima, Kyuya; Itagaki, Shinjiro; Iwasaki, Shin; Nakaya, Shigemasa (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 48-52(Dec 1970). (In Japanese).

Measurement of the E4 cross-over transition from the 4^+ state of ^{204}Pb was performed to study properties of the 4^+ state. The measurement of the cross-over transition of 1274 keV was carried out with a 42-cm^3 Ge(Li) detector. A lead absorber was used to reduce the intensity of the sum peak at 1274 keV, composed of 375-keV and 899-keV gamma rays. A source of ^{204}Pb was produced by the irradiation of enriched ^{206}Pb with 30-MeV bremsstrahlung. Identification of photopeaks seen in spectra was made by taking the decay of the peaks. The observed spectrum with the lead absorber was compared with the spectrum without the absorber. The intensity of sum peak in the peak at 1274 keV was estimated from the analysis of both spectra. Intensity of the cross-over transition relative to the E2 transition of 375 keV emitted from the 1274 keV level was $(1.18 \pm 0.89) \times 10^{-3}$. The experimental transition probability of the E4 transition was estimated to be six times larger than that calculated from the single-particle shell model. (Japan)

1631 PROPERTIES OF ^{211}At AS OBSERVED IN THE DECAY OF ^{211}Rn. Astner, G. (Forskningsinstitutet foer Atomfysik, Stockholm). Phys. Scr.; 5: No. 1-2, 31-40(1972).

The electron-capture decay of 15 h ^{211}Rn has been studied using mass-separated sources. All observed transitions stronger than 0.1% have been placed in a decay scheme. 93% of the electron-capture decays proceed to a state at 2479 keV (log ft = 5.6) which is interpreted to have the structure ^{212}Rn $\otimes$ $(s_{\frac{1}{2}}^{-1})$. A $\frac{1}{2}^-$ level at 674 keV should be the $f_{\frac{1}{2}}$ one-quasi-particle state whereas energies of levels at 866 keV ($\frac{1}{2}^-$), 947 keV ($\frac{3}{2}^-$), and 1116 keV ($\frac{3}{2}^-$) are in close agreement with theoretical predictions for a pure $\pi(h_{\frac{9}{2}}^3)$ configuration. Five states at an excitation energy between 1800 and 2200 keV should have the dominant configuration $\pi(h_{\frac{9}{2}}^2 f_{\frac{5}{2}})$. Their energies agree well with those derived assuming a pure configuration. (auth) (Sweden)

1632 g-FACTOR OF THE 15-STATE IN ^{210}At. Filevich, A. (Forskningsinstitutet foer Atomfysik, Stockholm); Rensfelt, K.-G.; Sztarkier, J.; Bergstroem, I.; Nakai, K. Phys. Scr.; 5: No. 1-2, 27-30(1972).

The g-factor of the 0.8-μs isomeric state at 2549 keV in ^{210}At was measured using the ^{209}Bi(α,3n)^{210}At reaction. The pulsed beam of the Stockholm 225-cm cyclotron and the stroboscopic method of measuring g-factors were used. The g-factor of the 0.8-μs isomeric state was found to be 1.03 ± 0.02. This value should be com-

pared with the calculated value 1.06 ± 0.03 which is established from known g-factors and the configuration suggested by Wikström et al. The measured g-factor supports the suggested configuration. (auth) (Sweden)

1633 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE STRUCTURE OF ^{210}Pb. Flynn, E. R. (Los Alamos Scientific Lab., N. Mex.); Igo, G. J.; Broglia, R. A.; (and others). Nucl. Phys.; A195: No. 1, 97-118(1972).

The ^{208}Pb(t,p)^{210}Pb reaction has been performed at a bombarding energy of 20 MeV. Angular distributions using solid-state counters and a magnetic spectrograph were obtained for levels up to 5 MeV of excitation. The different transitions are interpreted in terms of multipole pair addition modes, and support for the existence of multipole pairing fields is obtained from the analysis. The data are also compared with calculations using realistic force wave functions. No new correlations from the latter calculations not already present in the multipole pairing description were found. Special attention is paid to the transition to the 3$^-$ state at 1.869 MeV which has a large component of the two-phonon state $|3^- (^{208}\text{Pb}) \otimes \text{g.s.} (^{210}\text{Pb})\rangle$. It is shown that both ground state correlations and indirect transfer processes have to be invoked to explain the data. The two-step processes are treated in the coupled-channel Born approximation. (auth)

1634 PROTON-HOLE STATES IN ^{209}Bi FROM THE ^{210}Po(t,α) REACTION. Barnes, P. D. (Carnegie-Mellon Univ., Pittsburgh); Romberg, E.; Ellegaard, C.; (and others). Nucl. Phys.; A195: No. 1, 146-58(1972).

The ^{210}Po(t,α)^{209}Bi reaction has been studied at 20-MeV triton energy with an over-all resolution of 20 keV FWHM. Absolute cross sections were established by a comparison of the (t,α) intensities to elastic triton scattering. The three lowest single-proton states in ^{209}Bi were observed and spectroscopic factors were extracted from the measured cross sections by DWBA analysis. Starting at 2.43 MeV, six levels were strongly excited. These states have large 2p-1h proton components. The spectroscopic factors were extracted by a comparison of ^{210}Po(t,α) cross sections to ^{208}Pb(t,α)^{207}Tl single-proton-hole cross sections measured previously at the same bombarding energy. The observed states and their properties were analyzed within the framework of the particle- (or hole) vibration coupling model. Surface vibrational states in ^{208}Pb coupled to single protons as well as the proton pair addition modes (states in ^{210}Po) coupled to a proton-hole were included in the analysis. (auth)

1635 NEUTRON ANGULAR DISTRIBUTION ANALYSIS USING CYLINDRICAL BESSEL FUNCTIONS. Pearlstein, S. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 49: No. 2, 162-71(Oct 1972).

The principles of diffraction analysis as applied to neutron scattering are summarized. Angular distribution data from the elastic scattering of 14-MeV neutrons incident on targets over a mass range from A = 12 to A = 238 are parametrized using an expansion of terms containing Bessel functions as suggested by simple diffraction theory. Curve fits are obtained using fewer terms than with Legendre expansions, since the Bessel function terms are based on a physical model and have a natural line shape resembling the measurements. The diffraction-analysis method offers an alternative to the limitations inherent in nonphysically based methods and to the complexity intrinsic to nuclear optical-model calculations. (auth)

1636 LIFETIMES OF PRIMARY EXCITED STATES OF ^{203}Tl AND ^{205}Tl. Shubnyi, Yu. K.; Lysikov, Yu. A.; Kosyak, Yu. G. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 80-2(Jul-Aug 1971). (In Russian).

The lifetime of the primary 279-keV excited state of ^{203}Tl was determined by the method of resonance scattering. Compensation of energy loss in recoil is realized at the expense of a prior β transition. The energy distribution of the emitted quanta was calculated for a gaseous source without considering thermal motion of the nuclei, for a source at T = 300° and 800°C, and for a source in the form of the compound $HgCl_2$. The value of $P(E_p)$ does not significantly change for different temperatures of the source. It was assumed that rupture of the chemical bonds did not occur in the case of molecular sources. The lifetime of the 203-keV excited state of ^{205}Tl was determined by delayed coincidence. The radioactive isotopes ^{203}Tl and ^{205}Tl were obtained by irradiating Hg and HgO in a reactor. (tr-auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 97, 1532, 1539, 1581, 1635, and 2216.

1637 (AD-736841) EXPERIMENTAL TECHNIQUE FOR INVESTIGATING SPONTANEOUSLY FISSIONING ISOMERS. Temperley, J. K.; Morrissey, J. A.; Bacharach, S. L. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Dec 1971. 28p. (BRL-MR-2141). NTIS.

An experimental technique has been developed for investigating spontaneously fissioning isomers with half-lives ≥ 100 nsec. The technique uses four surface barrier fission detectors in a parallel configuration. The detectors are shielded from prompt fission events and observe fission fragments from events occurring at a catcher foil which collects heavy nuclei recoiling out of the target. The flexibility of the technique is demonstrated by reporting an experiment in which the half-lives, relative excitation energies, and single-fragment kinetic energy distributions of spontaneously fissioning isomers in ^{237}Pu were determined. (auth) (USGRDR)

1638 (ANL-7910, pp 1-29) FISSION PROPERTIES AND CROSS SECTION DATA. Jan 1972.

In Applied Physics Division annual report, July 1, 1970 to June 30, 1971.

CADMIUM — neutron elastic scattering at 2 MeV, optical-model analysis of cross sections and polarization using Hauser-Feshbach theory, (E/T)

GOLD-197 — neutron elastic scattering at 2 MeV, optical-model analysis of cross sections and polarization using Hauser-Feshbach theory, (E/T)

IRON-56 — neutron reactions (n,p) at 3.8 to 5 MeV, cross section for, (E)

LITHIUM-7 — proton reactions (p,n) at 3 to 7 MeV, differential cross section and relative yields for, (E)

NEUTRON CROSS SECTIONS — evaluation of, analysis of methods for

NICKEL-58 — neutron reactions (n,p) at 1 to 4.5 MeV, cross sections for, (E)

PLUTONIUM-239 — neutron fission at 30 keV, cross section relative to uranium-235, (E)

PLUTONIUM-240 — neutron total cross section at 0.1 to 1.6 MeV, (E)

— neutron elastic and inelastic scattering at 0.1 to 1.6 MeV, cross sections for, (E)

TANTALUM-181 — proton reactions (p,n) at 5 to 7 MeV, thick target yields for, (E)

TITANIUM — neutron total cross section at 0.1 to 18 MeV, evaluation for ENDF/B

— neutron reactions and scattering at 0.1 to 18 MeV, evaluation of cross sections for ENDF/B

— neutron elastic scattering at 2 MeV, optical-model analysis of cross sections and polarization using Hauser-Feshbach theory, (E/T)

TITANIUM-47 — neutron reactions (n,p) at 1 to 4.5 MeV, cross sections for, (E)

URANIUM-235 — neutron fission at 552 and 644 keV, cross sections for, (E)

— neutron fission at 2.5 MeV, cross section relative to uranium-238 for, (E)

— neutron fission at 30 keV, cross section relative to plutonium-239, (E)

URANIUM-238 — neutron fission at 2.5 MeV, cross section relative to uranium-235 for, (E) (J.W.R.)

1639 (EUR-4829) CALCULATIONS FOR FISSION NEUTRON AND GAMMA MULTIPLICITY MEASUREMENTS. Theobald, J. P.; Wartena, J. A.; Kolar, W. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Jul 1972. 22p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 40.-.

A set of detectors can be used to measure multiplicities of neutron or gamma quanta emitted in fission. Subsets of these detectors can be linked with coincidence units. Probabilities for x-fold coincidences are calculated for a given number of emitted particles or quanta. Methods of combinational analysis have been applied. (auth)

1640 (JINR-P1-6551) SEARCH FOR TRANSURANIUM ELEMENTS IN THE BOMBARDMENT OF URANIUM AND TUNGSTEN BY 70 GeV PROTONS. Batusov, Yu. A.; Vylov, Ts.; Zrelov, V. P.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of the experiments on the search for transuranium elements in the uranium and tungsten products irradiated by 70-GeV protons are given. ^{246}Cf was detected in the actinide fraction extracted from uranium. The heavier elements were not observed. (auth)

1641 (ORNL-4791, pp 21-51) CHEMISTRY AND PHYSICS OF TRANSURANIUM ELEMENTS. Aug 1972.

In Chemistry Division annual progress report for period ending May 20, 1972.

ACTINIDES—proton reactions up to 3 GeV, analysis of spallation–fission competition using intranuclear cascade model —electron binding energies of Z = 89 to 102, (E)
AMERICIUM—electron binding energies in, (E)
CALIFORNIUM BROMIDES—crystal structure of $CfBr_3$
CALIFORNIUM CHLORIDES—crystal structure of $CfCl_3$
NEPTUNIUM—complexes, crystal structure of $LiCo(NH_3)_6Np_2O_8(OH)_2 \cdot 2H_2O$
NOBELIUM-259—alpha spectra from, (E)
PLUTONIUM-239—neutron fission of, charge distribution of fragments from thermal, (E)
—carbon-12 reactions (C-12,α2n) and (C-12,α3n) at 67 to 97 MeV, analysis of reaction mechanism in, (E)
TRANSACTINIDE ELEMENTS—search for activities of superheavy, in nature, (E)
URANIUM-236—energy levels from deuteron elastic scattering, spin assignments for, (E)
URANIUM-238—carbon-12 reactions (C-12,5n) and (C-12,6n) at 67 to 97 MeV, analysis of reaction mechanism in, (E)
(J.W.R.)

1642 EXPERIMENTAL RESULTS CONCERNING LONG-RANGE LIGHT PARTICLES AND FRAGMENTS IN THE TERNARY FISSION OF ^{233}U, ^{235}U, ^{239}Pu AND ^{252}Cf. Cambiaghi, M.; Cavallari, F.; Fossati, F.; (and others) (Univ., Padua). Nuovo Cim.; 11A: No. 3, 716-24(1 Oct 1972).

The yields and energy spectra of ^{6}He particles from the thermal fission of ^{233}U, ^{235}U, and ^{239}Pu are reported. Data concerning ^{3}H emission in the ^{235}U fission are given, too. The spectrum relative to the alpha particles from ^{239}Pu was measured from the lower limit of 6 MeV. In the case of spontaneous fission of ^{252}Cf, the energy spectra of the fission fragments in correspondence with the emission of ^{3}H, ^{4}He, and ^{6}He particles were obtained. (4 figures, 5 tables) (auth)

1643 ABSOLUTE ^{238}U PHOTOFISSION CROSS-SECTION MEASUREMENTS USING THERMAL-NEUTRON-CAPTURE GAMMA RAYS. Domaschko, Joseph Maxmillian. Columbia, Mo.; Univ. of Missouri (1971). 146p. University Microfilms Order No. 72-19,199.

Thesis.

A study has been made of ^{238}U photofission using thermal-neutron-capture gamma rays with energies of 5.58, 6.072, 6.753, 7.724, 7.914, 8.881 and 8.997 MeV with Si(Li) solid-state detectors in coincidence. Absolute photofission cross-section measurements yielded values of 5.7, 17.6, 5.67, 4.8, 8.3, 10.8 and 12.9 mb, respectively. The K = 1 electric-dipole transition state was found to be a larger contributor to the photofission cross sections at 5.58 and 6.072 MeV than had been previously reported. An electric-quadrupole contribution was found with the 7.724-MeV photons but this form of fission mode was not observed at other gamma-ray energies. The 17.6 mb cross section at 6.072 MeV suggests a resonance in the vicinity. No asymmetry about the 90 degree scattering angle was indicated in this study. (Diss. Abstr. Int., B)

1644 LEVEL-SCHEME STUDIES IN ^{229}Th AND ^{231}Th FROM THE ALPHA-DECAY OF ^{233}U AND ^{235}U. Kroger, Larry Allan. Laramie, Wyo.; Univ. of Wyoming (1972). 140p. University Microfilms Order No. 72-18,334.

Thesis.

Due to the development of more efficient Ge(Li) detectors a study has been made of the gamma rays associated with the alpha-decay of the long-lived isotopes ^{233}U and ^{235}U to gain further information about the energy level structure of ^{229}Th and ^{231}Th. Of special significance in this study is the first reported gamma–gamma coincidence data taken with Ge(Li) detectors for these uranium isotopes. In addition, the present data represent the first study of the ^{235}U gamma-ray spectrum to be reported with these detectors. In this study, 34 gamma rays, a number of which were previously unreported, have been identified with the alpha-decay of ^{235}U and 30 of these have been placed into the ^{231}Th level scheme. The gamma-ray data have provided reliable supporting evidence for the previously identified Nilsson states $5/2^+[633]$, $5/2^-[752]$ and $7/2^-[743]$. The present data have also enabled the identification of the bandhead and first three rotational levels of the Nilsson orbital $3/2^+[631]$. The study of the gamma rays from the alpha-decay of ^{233}U has been of significant value in explaining some of the previously puzzling features of the ^{229}Th level structure. Of particular significance has been the identification of the $3/2^+[631]$ rotational band whose bandhead is estimated to be within 0.1 keV of the ^{229}Th ground state. Another result of this study is the tentative identification of the orbitals $3/2^-[761]$ and $5/2^-[752]$ and their lower-spin rotational members. Indirect evidence is also presented for possible configuration mixing in ^{229}Th between $3/2^-[761]$ and the $K^\pi = 0^-$ octupole vibration built on $3/2^+[631]$. The negative-parity Nilsson states observed in ^{229}Th and ^{231}Th originate from the $j_{15/2}$ spherical-shell-model state and thus are expected to mix through the Coriolis interaction. Direct calculations of this effect have been carried out and have provided a good semi-quantitative description of the observed spectrum of negative-parity states. Although the fit cannot be claimed to be unique, since many important parameters (particularly the positions of the members of the $1/2^-[770]$ band) are not known, the fact that reasonable fits to the data can be obtained under simple and realistic assumptions suggests that the general conclusions drawn from the analysis are essentially correct. (Diss. Abstr. Int., B)

1645 TIMES OF EMISSION OF K X RAYS FROM ^{235}U FISSION FRAGMENTS OF KNOWN MASS. Lerche, Richard Allan. Urbana, Ill.; Univ. of Illinois (1972). 125p. University Microfilms Order No. 72-19,866.

Thesis.

The yield of K x rays emitted from fission fragments of the thermal-neutron fission of ^{235}U is reported as a function of the time after fission for times between 1 to 60 nsec, as a function of the mass of the fragment emitting the x ray, and as a function of the total kinetic energy of the fragment pair emitting the x ray. Three-parameter data were recorded event by event. Two of the parameters contained information about the energies of the fission fragments from which it was possible to calculate the mass of each fragment. The third parameter contained information from which the elapsed time between the detection of one of the fission fragments and the detection of the x ray could be calculated. The timing data were sorted into x-ray timing spectra for fission-fragment mass intervals 4 amu wide and total kinetic energy intervals 5 MeV wide. Each timing spectrum was analyzed by fitting it with a function that represented the prompt response of the timing system folded with three exponential decays. The average numbers of K x rays emitted per light- and heavy-fragment group were found to be 0.07 ± 0.03 and 0.15 ± 0.02, respectively. The results suggest that most of the x rays emitted by the light fragments are caused by the internal conversion of E2 transitions and that x rays emitted by heavy fragments are caused by a mixture of E2 and M1 transitions. For fragment masses above 150 amu, evidence is presented that indicates the increase in x rays emitted per fragment is due to the internal conversion of M1 transitions. (Diss. Abstr. Int., B)

1646 α-DECAY WIDTHS OF EVEN-EVEN NUCLEI WITH NEAR-MAGIC NUMBERS. Kar'yan, N.; Sandulesku, A. (Inst. of Atomic Physics, Bucharest). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 129-36(Jan 1972). (In Russian).

New α emitters had been discovered by recent precision work on linear accelerators of heavy ions at Berkeley and on the CERN synchrocyclotron. This material was examined for evidence of agreement or contradiction with existing theories of α decay. The examination was generally limited to even isotopes of Po, Rn, Ra, and Th. (K.S.W.)

1647 AVERAGE KINETIC ENERGIES AND ANGULAR DISTRIBUTIONS OF FISSION FRAGMENTS FROM ^{238}Pu AND ^{239}Pu. Nikolaev, V. A.; Protopopov, A. N. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 215-18(Jan 1972). (In Russian).

Measurements of the average kinetic energies of fission fragments of ^{238}Pu and ^{239}Pu as a result of fast neutrons in the range 800 to 1100 keV were made. The technique employed glass detectors with filters which also yielded data on angular distribution. (tr-auth)

1648 RELATIVE YIELDS OF XENON ISOTOPES IN ^{237}Np AND ^{238}Np FISSION BY NEUTRONS. Petrzhak, K. A.; Pan'yan, M. G.; Teplykh, V. F.; Aleksandov, B. M. (Leningrad Technological Inst.). Yadern. Fiz.; 15: No. 5, 860-2(May 1972). (In Russian).

Relative yields of xenon isotopes in ^{237}Np and ^{238}Np fission by reactor neutrons were determined with a mass-spectrometric method. A small thin fission product structure was found in ^{237}Np fission by the fast neutrons and sharp structure in ^{238}Np fission by thermal neutrons in the A = 131 – 136 mass number region. (auth)

1649 INTERMEDIATE RESONANCES IN THE NEUTRON TOTAL CROSS SECTION OF ^{235}U AT LOW ENERGIES. Kitazoe, Y.; Suzuki, H.; Sekiya, T. (Osaka Univ.). Atomkernenergie; 20: No. 1, 13-18(Sep 1972).

The formal theory of nuclear reactions is applied to investigate the existence of intermediate resonances in the neutron total cross section of ^{235}U at low energies (E = 0 to 300 eV). Particular attention is paid to clarifying a relation between the most complicated mechanism states (compound nucleus states) and simpler mechanism states. The theory is compared with the R-matrix theory from the theoretical point of view and, at the same time, through the practical evaluation of the cross section of ^{235}U. The evaluated

cross section is in good agreement with experiment from a qualitative viewpoint. (4 figures, 4 tables) (auth)

1650 BAND OF RESIDUAL POWERS DUE TO THE FISSION OF ^{235}U AND ^{239}Pu. III. EXPERIMENTAL AND THEORETICAL RESULTS FOR A FAST NEUTRON SPECTRUM. Costa, L.; Rastoin, J.; de Tourreil, R. (CEN, Fontenay-aux-Roses, France). J. Nucl. Energy; 26: No. 8, 431-41(Aug 1972).

A new measurement and a comparative study with theoretical computations based on the fission products properties for the $(\beta + \gamma)$, γ and β residual powers due to an elementary fission produced by a fast neutron reactor spectrum, are presented. From the results, it is concluded that new measurements are necessary to confirm the precision of the theoretical evaluations for cooling time $\tau \geq 10^6$ sec. The good agreement with calorimetric measurements shows that the precision of the theoretical computations is better than 5% when the cooling time $\tau \geq 10^6$ sec. Taking into account the fact that the fission product properties are the same for decay time $\tau \geq 10^3$ sec. the same conclusion can be expected for $10^3 < \tau < 10^6$ sec. in spite of the lack of precise measurements during this cooling interval. For cooling time $\tau < 10^3$ sec the same conclusions hold as in part II. (auth) (UK)

1651 LEVELS OF ^{230}Th OBTAINED IN THE DECAY OF ^{230}Pa. Valkeapaeae, T.; Heinonen, J.; Graeffe, G. (Helsinki Univ. of Tech., Otaniemi, Finland). Phys. Scr.; 5: No. 3, 119-25(1972).

The decay of ^{230}Pa to the levels of ^{230}Th has been investigated using semiconductor detectors for gamma and electron singles-spectra measurements and Ge(Li) detectors combined with a NaI(Tl) detector for gamma–gamma coincidence measurements. Some weak gamma transitions not reported earlier were observed. A decay scheme is presented which counts all of the transitions observed in the present work. The following bands are established in ^{230}Th: The ground state band (2^+, 4^+, 53.2 keV, 174 keV), the beta quadrupole band (0^+, 2^+, 635.1 keV, 677.3 keV), the gamma quadrupole band (2^+, 3^+, 781.4 keV, 825.8 keV), the $K^\pi = 0^-$ octupole band (1^-, 3^-, 508.1 keV, 571.8 keV), the $K^\pi = 1^-$ octupole band (1^-, 2^-, 3^-, 951.7 keV, 971.6 keV, 1 012.5 keV) and the $K^\pi = 2^-$ octupole band (2^-, 3^-, 1 079.3 keV, 1 127.4 keV). The 2^+ state at 1 009.5 keV is thought to be a two-phonon state. The experimental data are discussed in terms of nuclear models and compared with those of other authors. The beta feeding to the states in ^{230}Th has been discussed from the point of view of the two quasi-particle composition of the vibrational states. (auth) (Sweden)

1652 LIFETIME MEASUREMENT IN ^{245}Cm. Ansaldo, E. J.; Bengtson, B. (Univ. of Aarhus, Denmark). Phys. Scr.; 5: No. 1-2, 22(1972).

The half-lives of the 388-keV and 55-keV levels of ^{245}Cm were determined to be $T_{\frac{1}{2}}$(388 keV) = 0.450 ± 0.020 nsec and $T_{\frac{1}{2}}$(55 keV) ≤ 0.10 nsec. (auth) (Sweden)

1653 ELECTRON CAPTURE DECAY OF ^{240}Am. Ahmad, I.; Barnes, R. F.; Sjoblom, R. K.; Fields, P. R. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 34: No. 11, 3335-43(Nov 1972).

The γ-ray and conversion electron spectra of mass-separated ^{240}Am samples were measured with high-resolution Ge(Li) and Si(Li) spectrometers. The conversion coefficients of the 42.9, 99.0, 888.7, and 987.7 keV transitions were measured and their multipolarities were established as E2. A ce^--γ-ray coincidence experiment showed that the 888.7 and 987.7 keV transitions originate from a 1030.6 keV level. On the basis of the measured log ft value the ground state of ^{240}Am was given a spin-parity assignment of 3- with the configuration {n[631] $1/2+$; p[523] $5/2-$}. The 1030.6 keV level of ^{240}Pu was given a spin-parity assignment of 3+ with the two-quasi-particle configuration {n[631] $1/2+$; n[622] $5/2+$}. Several other low intensity γ-rays were observed. The half-life of ^{240}Am was measured to be 50.8 ± 0.3 hr which is in agreement with previously reported values. (auth)

1654 ENERGY SPECTRUM OF NEUTRONS OF TERNARY FISSION OF ^{252}Cf NUCLEI. Graevskii, A. P.; Bochagov, B. A.; Kupriyanova, L. N. (Leningrad Inst. of Nuclear Physics). JETP Lett. (USSR) (Engl. Transl.); 15: No. 9, 407-9(5 May 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 9, 572-4(5 May 1972).

The energy spectra of the neutrons from the ternary fission of ^{252}Cf were measured by the time-of-flight method with a base of 0.5m and a resolution of ±2.5 nsec. (L.T.W.)

1655 NUCLEAR CHARGE DISPERSION IN THE FISSION OF ^{237}Np BY PROTONS OF MEDIUM ENERGY. McGee, T.; Rao, C. L.; Yaffe, L. (McGill Univ., Montreal). J. Inorg. Nucl. Chem.; 34: No. 11, 3323-33(Nov 1972).

Independent formation cross-sections of ^{129}Cs, ^{130}Cs, ^{131}Cs, ^{132}Cs, ^{134m}Cs, ^{134g}Cs, ^{135m}Cs, and ^{136}Cs and the cumulative formation of ^{140}Ba in the fission of ^{237}Np by protons of energies 20 to 85 MeV were determined. The most probable charges, Z_p, at the various bombarding energies agree with predictions made. No correlation with nuclear charge postulates was found. An estimate was made of the numbers of neutrons emitted at various bombarding energies. (auth)

1656 NEUTRON CAPTURE, FISSION, AND TOTAL CROSS SECTIONS OF ^{240}Pu FROM 20 eV TO 30 keV. Hockenbury, R. W.; Moyer, W. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(11-1)-3058. Nucl. Sci. Eng.; 49: No. 2, 153-61(Oct 1972).

The neutron capture and fission cross sections of ^{240}Pu were measured from 20 eV to 30 keV. Transmission measurements were also made from 30 to 500 eV. The capture data were normalized using the transmission results to minimize the uncertainty in absolute normalization. The average capture cross section was determined from 6 to 30 keV. The s-wave average radiation width was found to be (0.0295 ± 0.0015) eV. Resonance parameters to 500 eV and an s-wave strength function of $(1.10 \pm 0.27) \times 10^{-4}$ were also obtained. Sub-threshold fission structure was observed up to 30 keV. The level spacing for sub-threshold fission was found to be (710 ± 200) eV. Comparisons of all results are made to previously published data. (5 figures, 4 tables) (auth)

1657 TOTAL NEUTRON CROSS SECTIONS OF THE CURIUM ISOTOPES FROM 0.01 TO 30 eV. Berreth, J. R. (Aerojet Nuclear Co., Idaho Falls, Idaho); Simpson, F. B.; Rusche, B. C. Nucl. Sci. Eng.; 49: No. 2, 145-52(Oct 1972).

The total neutron cross sections have been measured and resonance parameters determined for ^{243}Cm, ^{245}Cm, and ^{246}Cm from 0.01 to 30 eV and for ^{244}Cm up to 90 eV. A total thermal neutron cross section at 0.0253 eV was determined for ^{244}Cm of 23 ± 3 b and 2900 ± 450 b for ^{245}Cm. Resonance absorption integrals of 2345 ± 470 b for ^{243}Cm, 605 ± 40 b for ^{244}Cm and 897 ± 180 b for ^{245}Cm were calculated from the resonance parameters. (auth)

1658 RATIO OF THE ^{238}U TO ^{235}U FISSION CROSS SECTIONS FROM 1 TO 5 MeV. Meadows, J. W. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 49: No. 3, 310-16(Nov 1972).

Measurements of the ^{238}U:^{235}U fission cross section ratio were carried out in the 2 to 3 MeV region using two different methods to determine the relative masses. The energy dependence of the ratio was measured from 1 to 5 MeV and normalized to the results at 2.5 MeV. The measured value of the ratio at 2.5 MeV is 0.432 ± 0.004. (auth)

Nuclear Theory

Refer also to abstracts 97, 1360, and 1569.

1659 (BNL–17109) PERTURBATION SERIES APPROACH TO NUCLEAR MATTER. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y.). 1972. 11p. (CONF-720933–1). Dep. NTIS.

From Symposium on present status and novel developments in the nuclear many-body problem; Rome, Italy (Sep 1972).

Problems encountered in the calculation of the ground-state energy of nuclear matter using a perturbation series approach are discussed. (J.W.R.)

1660 (COO–7–631) ANGULAR CORRELATION OF NUCLEAR RADIATION FROM ISOTROPIC SOURCES. Scherer, C. (Wisconsin Univ., Madison. Dept. of Physics). 1971. Contract AT-(11-1)-Gen-7. 28p. Dep. NTIS.

A method is developed for the evaluation of the perturbed angular correlation of two particles successively emitted by nuclei embedded in sources where the interaction between the nuclei and the environment is isotropic on the average. The method can be applied with any value of the correlation time τ_c. It is shown that in the limit of small τ_c, if the source is also homogeneous and the perturbing process is stationary during the nuclear lifetime, the attenuation coefficients $G_k(t)$ are single exponentials, a result which is not restricted to those cases where perturbation theory is applicable. The case of a time dependent hyperfine interaction associated with randomly distributed static quadrupole interactions is studied. (auth)

1661 (COO–7–632) NUCLEAR SPECTROSCOPY. II. CHAPTER 2-A. POLARIZED BEAMS. Haeberli, W. (Wisconsin Univ., Madison. Dept. of Physics). 1972. Contract AT(11-1)-GEN-7. 79p. Dep. NTIS.

A review on polarization phenomena in nuclear reactions and scattering is presented which should serve as a thorough introduction to the basic theory, terminology, and the experimental methods. (J.W.R.)

1662 (COO–2022–15) UNIQUENESS OF R-MATRIX PARAMETERS IN THE ANALYSIS OF LOW-ENERGY NEUTRON CROSS

SECTIONS OF FISSILE NUCLEI. Adler, D. B.; Adler, F. T. (Illinois Univ., Urbana. Dept. of Physics). 1972. Contract AT(11-1)-2022. 50p. Dep. NTIS.

The existence of different sets of R-matrix parameters describing the same cross sections for a given spin-parity state was studied in the context of low-energy neutron reactions in fissile elements. For two-fission channels and well-spaced resonances different sets of fission vectors were found describing essentially the same set of cross-section curves. (auth)

1663 (COO-2171-1) VALIDITY OF SPECTRAL DISTRIBUTION METHODS IN SPECTROSCOPY. Chang, F. S.; Zuker, A. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 1972. 25p. Dep. NTIS.

The accuracy with which various spectral distributions reproduce the energies in many-particle spectra was studied by comparing the results with those from an exact (ds)-shell calculation of dimensionality ranging up to 1200. Also investigated was the splitting of the deviations, between the distribution and exact spectra, into a fluctuating part and a part which varies slowly with energy, as well as the accuracy with which the distribution method reproduces the orbit occupancies over the entire range of excitation energies as well as the level density and spin-cut-off factor. Agreement in all cases was good. (auth)

1664 (COO-3001-16) MAGNETIC DIPOLE TRANSITIONS IN THE VICINITY OF ^{208}Pb. Arima, Akito; Huang-Lin, Lih Jen (State Univ. of New York, Stony Brook. Dept. of Physics). 1972. 13p. Dep. NTIS.

Magnetic dipole transition rates were calculated in the vicinity of ^{208}Pb. The effects of core polarization and mesonic exchange current, which seem to be the two main mechanisms to renormalize the nuclear M1 operator, were taken into account. The calculated rates were in impressive agreement with the recent measurements made by the Chalk River Group. The effect of exchange current competes with that of core polarization in l-forbidden M1 transitions, but the former is negligible in allowed M1 transitions. A reason is clarified. (auth)

1665 (INR-P-1419) DISCUSSION OF THE STRUCTURE OF NUCLEAR ROTATION AT HIGH-ANGULAR MOMENTA. Krumlinde, J.; Szymanski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 100p. Dep. NTIS (U. S. Sales Only).

A schematic two-level model is introduced and developed in order to describe the nuclear rotation at high angular momenta. For this problem there exists a symmetry of the Lie algebra belonging to the group R(8). The implications of this symmetry including various subalgebras of R(8) corresponding to different particular cases are studied. It is found that the model is able to describe qualitatively (i) the phase transition from the superfluid to the normal state, (ii) the band structure in the region above the phase transition, and (iii) the retardation of the γ transitions across the phase transition. (auth)

1666 (IPNO/TH-72-5) ENERGY DENSITY FORMALISM IN NUCLEI. Lombard, R. J. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Apr 1972. 60p. Dep. NTIS (U. S. Sales Only).

A revised version of the energy density formalism is presented which allows one to describe the bulk properties of nuclei accurately. As far as the binding energies are concerned, the approach is shown to be competitive with semi-empirical mass formulas. The nuclear radii are also in good agreement with experiment. Calculations of the electron scattering differential cross section at medium energy show, however, that the surface of charge distributions is not yet satisfactory. An extension of the functional giving the total energy density is proposed in which the single-particle structure of nuclei is taken into account. In a first step the many-body wave function corresponds to a Slater determinant of single-particle wave function but extension to more general wave function is straightforward. This extended approach is similar to the local density approximation. (auth)

1667 (JINR-P4-6591) PROBLEM OF ANGULAR CORRELATIONS IN DIRECT NUCLEAR REACTIONS. Titov, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A general equation is obtained for the angular correlations in direct nuclear reactions. A particular case of plane-wave approximation is analyzed, and the distortions are taken into account within the high-energy approximation in the Li ion reactions. (auth)

1668 (NASA-TM-X-68134) DEFORMED BRUECKNER-HARTREE-FOCK CALCULATIONS. Ford, W. F.; Braley, R. C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center); Becker, R. L.; Patterson, M. R. (Oak Ridge National Lab., Tenn.). 1972. 31p. (CONF-720933-3). Dep. NTIS.

From Symposium on present status and novel developments in the nuclear many-body problem; Rome, Italy (19 Sep 1972).

The renormalized Brueckner-Hartree-Fock (RBHF) theory for many-body nuclear systems has been generalized to permit calculations for intrinsic states having permanent deformation. Both Hartree-Fock and Brueckner self-consistencies are satisfied, and details of the numerical techniques are discussed. The Hamada-Johnston interaction is used in a study of deformations, binding, size, and separation energies for several nuclei. Electromagnetic transition rates, moments, and electron scattering form factors are calculated using nuclear wave functions obtained by angular momentum projection. Comparison is made to experiment as well as to predictions of ordinary and density-dependent Hartree-Fock theory. (auth)

1669 (UCRL-Trans-10648) APPLICATION OF THE STATISTICAL MODEL TO (n,n'γ) EFFECTIVE CROSS SECTIONS IN THE MASS RANGE A = 46 TO 88. Uhl, M. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Nucl. Phys.; A184: No. 1, 253-72(1972). 32p. Dep. NTIS.

Using an accurate version of the statistical model (n,n'γ) cross sections for 19 even isotopes of Ti, Cr, Fe, Ni, Zn, Ge, Se and Sr have been calculated. The influence of the various parameters of the model is examined. The results are compared with experimental cross sections for 14 MeV neutrons; applying a correction for direct-interaction contributions, the agreement is satisfactory. The connection of the systematic behavior between the (n,2n) and that of (n,n'γ) cross sections is discussed. (auth)

1670 WIGNER SUPERMULTIPLET MODEL FOR NUCLEAR BINDING ENERGY FORMULAE. Prael, Richard Edward. Cleveland; Case Western Reserve Univ. (1972). 130p. University Microfilms Order No. 72-18,726.

Thesis.

The "symmetry" energy contribution to the nuclear binding energy resulting from an arbitrary mixture of charge and spin independent central forces is derived from the assumption of supermultiplet (SU(4)) symmetry for nuclear ground state wave functions. The effect of SU(4) symmetry breaking by Bartlett and Heisenberg forces of a short-range or pairing character is calculated in first-order perturbation theory for an L-S coupling seniority model assuming unmixed shell model configurations 1^n. The group chain $U(21+1) \supset R(21+1) \supset R(3)$ is used to classify spatial wave functions and the corresponding coefficient of fractional parentage expansion is used to obtain the matrix elements of the SU(4) symmetry-breaking interactions. The resulting expressions emphasize the difficulty of trying to account for the nuclear symmetry energy for any but the lightest nuclei on the basis of the supermultiplet model, even in the absence of other symmetry-breaking interactions. The calculation of matrix elements for charge-independent, SU(4) symmetry-breaking central forces is generalized to include charge-dependent central forces. Coulomb energy formulae are derived in the supermultiplet-seniority model which parallel existing calculations for the "space-scalar" supermultiplet scheme and the j-j coupling seniority scheme. The inclusion of seniority coupling in the supermultiplet model removes discrepancies noted in previous supermultiplet-based Coulomb energy calculations. The comparison of Coulomb energy calculations for the different models points out the limitations common to the three schemes in describing the fine structure observed in Coulomb energy difference data. (Diss. Abstr. Int., B)

1671 MULTIPLE STEP NUCLEON TRANSFER REACTIONS IN LIGHT NUCLEI. Singh, Raj Narain. Montreal; McGill Univ. (1971). National Library of Canada, Ottawa.

Thesis.

Multi-step processes in nuclear transfer reactions have been investigated using the coupled-channel method. The formalism involved has been written down for arbitrary spin-isospin states, and the various approximations (e.g., the zero range force) required while carrying out a calculation have been studied. A computer code to carry out coupled-channel calculations has been developed and is used to study the reactions $^{12}C(^3He,\alpha)^{11}C$ and $^{18}O(^3He,\alpha)^{17}O^*$. The results are compared to the DWBA results. It is found that multi-step processes are often very important for both inelastic and transfer reactions, and both types of channels should be included in a coupled-channel analysis. The cross sections to states forbidden in first order DWBA are also calculated through the coupled-channel program. A general discussion of the factors involved in carrying out such a calculation is presented. (Diss. Abstr. Int., B)

1672 USE OF FADDEEV EQUATIONS FOR REACTIONS INVOLVING DOUBLE-NUCLEON EMISSION. Soto, Humberto Gar-

cilazo. Charlottesville, Va.; Univ. of Virginia (1972). 100p. University Microfilms Order No. 72-22,650.

Thesis.

The absorption of a bound negative pion by a nucleus results in most of the cases in the emission of two nucleons which come out of the nucleus with very high energy but little total momentum. The final state of the system is formed by the two outgoing nucleons and the residual nucleus, and therefore is a three body system. The theory of three-body systems based on the Faddeev equations is presented, and it is adapted to be used in nuclear reactions leading to the simultaneous emission of two nucleons. The equations are transformed to a form which is practical for calculation of processes with two identical particles. Numerical results are presented for double nucleon emission following pion absorption in ^{12}C for the case when the pion is absorbed from a 2P atomic orbit. The effects of the nucleon-pair short range correlations inside the nucleus are studied by means of the results. (Diss. Abstr. Int., B)

1673 COUPLED VIBRATIONS IN HEAVY SPHERICAL NUCLEI. Siegal, Charles David. Pittsburgh; Carnegie-Mellon Univ. (1972). 186p. University Microfilms Order No. 72-21,604.

Thesis.

A formalism for studying two-particle-two-hole states in closed shell nuclei is developed by coupling two particle-hole phonons or a particle–particle and a hole–hole phonon. The theory is constructed so that the phonons can either neglect ground state correlations of the closed shell system (Tamm–Dancoff Approximation) or include them (Random Phase Approximation). Ways of combining p-h and pp-hh correlations are discussed. As a digression, a method of treating the J = 0 (pairing) excitations of the closed shell system is developed (Generator Coordinate Method). It is found that the approach can describe the low-lying 0^+ states in ^{208}Pb, but only if the correlations are included, the simpler TDA being not a good approximation. The 2^+ states in ^{208}Pb can be partly understood, though lack of a good renormalized realistic interaction hampers the comparison between theory and experiment. (Diss. Abstr. Int., B)

1674 APPLICATIONS OF THE SYMMETRIC GROUP TO THE NUCLEAR N-BODY PROBLEM. Harding, William Harry Jr. Austin, Tex.; Univ. of Texas (1971). 94p. University Microfilms Order No. 72-19,598.

Thesis.

Certain general group theoretical concepts are employed in the calculation of an isospin-free Hamiltonian matrix. The correspondence between the eigenvalue of the total isospin operator of an N-nucleon system and a partition of the group of permutations on the isospin coordinates of that system is used in this scheme. A sample four-nucleon problem using this scheme is presented and analyzed. A discussion of a general scheme and possible applications is given. (Diss. Abstr. Int., B)

1675 EQUILIBRIUM DEFORMATIONS AND DEFORMABILITIES OF NUCLEUS-FRAGMENTS. Rubchenya, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 212-14(Jan 1972). (In Russian).

The energy of deformation of even-even nucleus-fragments obtained in the fission of ^{235}U by slow neutrons was calculated by the Strutinskii method of shell correction to the semi-empirical mass formula of Bethe–Weizsaecker. (tr-auth)

1676 STATISTICAL DESCRIPTION OF RADIATION WIDTHS. Ignatyuk, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 202-7(Jan 1972). (In Russian).

The influence of shell structure of a spectrum of single-particle states of nucleons on the behavior of average radiation widths of excited nuclei was considered. The γ-quanta spectra obtained and the dependence of the radiation width on the excitation energy are significantly different from the results of the statistical description by Weisskopf. (tr-auth)

1677 CALCULATION OF BOND ENERGIES AND MEAN-SQUARE RADII FOR SUPER-HEAVY NUCLEI. Sadovoi, A. A.; Rybachenko, V. F.; Aber'yanov, I. K. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 198-201(Jan 1972). (In Russian).

Binding energies and root-mean-square radii were calculated for a series of super-heavy nuclei near Z = 112 and Z = 168 with nucleon numbers of from 224 to 480, using a method of hyperspherical functions. The use of local two-particle nucleon-nucleon potentials in the form of two Gaussian curves yielded results which point to the possible existence of nuclei $^{280}112$ and $^{408}168$. The latter would be stable relative to nucleon decay. (tr-auth)

1678 DEUTERON OPTICAL POTENTIAL ALLOWING FOR EFFECTIVE INTERACTION BETWEEN NUCLEONS. Solov'ev, V. A.; Chernov, I. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 190-3(Jan 1972). (In Russian).

A correction factor was evaluated in the effective portion of the deuteron optical potential through a comparison of the experimental and calculated cross sections. The magnitude of the correction for a wide range of atomic nuclei and the energies of the incident particles amount to 15% of the total nucleon potentials. (tr-auth)

1679 PREDICTION OF DEUTERON SCATTERING CROSS SECTIONS BY NEUTRON-EXCESSIVE AND NEUTRON-DEFICIENT NUCLEI OF NICKEL. Kabakova, N. E.; Korbetskii, E. V.; Sokolov, L. S. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 187-9(Jan 1972). (In Russian).

Differential cross sections of elastic and inelastic deuteron scattering (E_d = 13.6 MeV) by Ni isotopes with mass numbers A = 48 to 78 were calculated using a vibrational model. The dependence of the magnitude and phase of the cross sections was predicted as a function of the number of neutrons in the target nucleus. (tr-auth)

1680 CALCULATIONS OF INELASTIC CROSS SECTIONS OF INTERACTION OF NEUTRONS WITH ENERGIES $E_n \lesssim 20$ MeV WITH LIGHT AND MEDIUM NUCLEI. Dzyuba, B. M.; Aver'yanov, I. K.; Savel'ev, A. E. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 184-6(Jan 1972). (In Russian).

Calculations of inelastic cross sections of interaction of neutrons with nuclei such as ^{28}Si, ^{51}V, and ^{56}Fe were made, allowing for a considerable "penetrability of nuclear surface" factor. The "penetrability" was derived from an optical potential in the form of the Bjorklund–Fernbach potential. The cross sections of neutron interaction were essentially zero up to about 5 MeV, then rose rather sharply with increasing neutron energy. Satisfactory agreement between calculated and experimental values was observed. (K.S.W.)

1681 EMPIRICAL DEPENDENCE OF THE LEVEL DENSITY OF HEAVY NUCLEI ON THE ENERGY OF EXCITATION. Vorotnikov, P. E. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 175-9 (Jan 1972). (In Russian).

An analysis of the experimental data on radiative capture cross sections and inelastic neutron (0.5 to 5 MeV) scattering by the nuclei ^{232}Th and ^{239}Pu was conducted within the framework of the theory of nuclear reactions. The density of levels $\rho^0 = \rho_I (2I + 1)$ was determined as a function of the energy of excitation over the interval 1 to 8 MeV. (tr-auth)

1682 FINE STRUCTURE OF THE CROSS SECTION OF PHOTONUCLEAR REACTIONS. Dubovoi, E. I. (Inst. of Radiotechnology, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 169-72(Jan 1972). (In Russian).

The diagram theory of nuclear reactions predicted the existence of fine structure in photonuclear reaction cross sections in nuclei with cluster structure. The position, spin, and parity of these resonances were determined. Irregularities in the cross section of the (γ,n) reaction for ^{16}O were analyzed; resonances at 17 to 25 MeV were identified with extremes in the triangular Feynman diagrams. Resonances at 17 to 20 MeV were intensified by the formation of "internal-excited threshold states" by a virtual proton and by the excited core of a ^{16}O nucleus–^{15}N nucleus. (tr-auth)

1683 COLLECTIVE MOTIONS AND SINGLE PARTICLE MODELS. Mang, H. J. (Technische Univ., Munich). J. Phys., A (London); 5: No. 7, 929-35(Jul 1972).

The connection between single-particle and collective motion is discussed on the basis of the generator coordinate method. Earlier and recent work on the subject is reviewed. (auth)

1684 ^{195}Pt AND THE CORE-EXCITATION MODEL. Raju, M. L. N.; Satyanarayana, G.; Tirumala Rao, B. V.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Curr. Sci. (India); 41: No. 17, 649-50(5 Sep 1972).

The applicability of the core-excitation model to the low-lying levels of ^{195}Pt was tested. Transition probabilities were calculated and compared with experimental data. A good agreement was found. (J.W.R.)

1685 PROBABILITIES OF E2-TRANSITIONS BETWEEN ROTATIONAL STATES OF DEFORMED NUCLEI. Zakrevskii, N. V. (Leningrad Mechanical Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 125-8(Jan 1972). (In Russian).

The ratios of the probabilities of E2-transitions between rotational states of deformed even-even nuclei $I^\pi = 4^+, 6^+, 7^+, 8^+$ were studied. For the nucleus group with $152 \leq A \leq 190$ a comparison of experimental and calculated results is presented based on the Davydov–Chaban model and on the R-V model of Fessler and Greiner. (tr-auth)

1686 MULTIPLETS OF TWO-PARTICLE CONFIGURATIONS OF THE TYPE $[j_1^1\ j_2^1]$ OF EVEN–EVEN NUCLEI. Peker, L. K.;

Sliv, L. A.; Kharitonov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 89-98(Jan 1972). (In Russian).

Characteristics of splitting of multiplets of two-particle configurations of even-even nuclei under the influence of residual forces with the final and zero radius of interaction. A rule was formulated for deriving low level spins of such multiplets. The conclusions obtained were compared with available experimental data. (tr-auth)

1687 SYSTEM OF EXPERIMENTAL VALUES FOR DESCRIBING THE CHARACTER OF DEFORMED NUCLEI. Dzhelepov, B. S. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 1, 2-16(Jan 1972). (In Russian).

A system of constants is discussed which is based on a physical hypothesis of nuclear structure which introduces no new unknown values, but which describes deformed nuclei and rotational bands. Principles of mixing wave functions are examined, and cases in which mixing is slight are outlined. Components of many particle systems were investigated with quantum numbers differing from $I^{\pi}K$. Formulas are presented which deal with the probabilities of γ radiation, electrical and magnetic moments, and band energies. These formulas were applied to bands $K^{\pi} = 1^{-}$ and $K = 0$ in ^{170}Tm, and bands $K^{\pi} = 1/2^{-}$ and $K^{\pi} = 3/2^{-}$ in ^{183}W. (K.S.W.)

1688 DISTORTION OF THE DEUTERON BY THE COULOMB FIELD. Coffou, E. (Ruder Boskovic Inst., Zagreb). Fizika (Zagreb); 4: No. 3, 141-56(Jul 1972).

The deformation of the internal deuteron wave function by the Coulomb field of the nucleus has been considered. The relevant characteristic physical quantities have been evaluated. The influence on the angular distribution of the outgoing particles in deuteron stripping reactions has been calculated. The results are given in the form which allows a rough estimation of this effect without performing numerical calculations in each particular case. (auth)

1689 REDUCTION RELATIONS FOR THE THIRD AND THE FOURTH MOMENTS OF ENERGY SPECTRA IN A MANY-PARTICLE CONFIGURATION. Nomura, Masao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 110-32(Jul 1972).

The third and fourth moments of energy spectra in a many-particle configuration are completely related to two-particle matrix elements, so that neither cfp nor explicit diagonalization of any matrix is needed to evaluate these moments. Recah algebra and reduction relations for cfp are used. j^n and $j_1^{n_1}j_2^{n_2}$ configurations of identical particles only are considered. (auth)

1690 BINDING ENERGIES OF ^{4}He and ^{3}H IN REACTION MATRIX THEORY. Akaishi, Yoshinori (Hokkaido Univ., Sapporo); Nagata, Sinobu. Progr. Theor. Phys. (Kyoto); 48: No. 1, 133-59(Jul 1972).

The binding energies of ^{4}He and ^{3}H are calculated with some realistic potentials in the reaction matrix theory. The reaction matrix equation is derived from the internal Hamiltonian. The energy denominator is given after careful consideration of the difference between the total energies of the starting state and the intermediate state. The Pauli operator is treated without approximation in the two-particle scattering process in nuclei. The calculated binding energies of ^{4}He and ^{3}H with Hamada–Johnston potential are 19.5 MeV and 6.3 MeV, respectively. The scattering wave function is also obtained. The root mean square radii with the correlated wave functions are 1.64 fm and 1.67 fm for ^{4}He and ^{3}H, respectively. It is found that the contribution from tensor force in ^{3}E state is very large, as compared with that in nuclear matter, and it is very important in order to obtain the sufficient binding energies of light nuclei to take into account this contribution through the two-particle scattering process in nuclei. The D state mixing ratios are about 14% and 8.5% for ^{4}He and ^{3}H, respectively. The various correlation energies are estimated and it is found in the case of ^{4}He with H–J that the hole–hole diagram contributes about 3 MeV and potential insertion in the particle states just above the Fermi surface brings about 2 MeV. It is concluded that validity of the independent pair model is confirmed very well in the lightest nuclei similar to the case of nuclear matter. (auth)

1691 NUCLEAR LEVEL DENSITY AND INERTIA PARAMETERS. Sano, Mitsuo; Wakai, Masamiti (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 1, 160-81(Jul 1972).

The formulae of calculation of the nuclear level density based on the theory of superconductivity are presented. Special attention is paid to the dependence of the level density on the angular momentum. The moment of inertia is evaluated using the cranking model. For a deformed nucleus, the Coriolis anti-pairing effect is taken into account. The formulae do not contain any open parameters. Numerical calculations are made for the single-particle spectrum of the Nilsson model without the use of asymptotic integral expressions. The results of calculations are compared with experimental data for ^{68}Ge and ^{242}Pu. The agreement is satisfactory. (auth)

1692 FORWARD DEUTERON EMISSION IN HIGH ENERGY PROTON–NUCLEUS COLLISION AND NUCLEAR CORRELATIONS. Kohmura, Toshitake (Tokyo Univ. of Education); Tanabe, Kosai; Futami, Yasuhiko; Fujii, Akihiko. Progr. Theor. Phys. (Kyoto); 48: No. 1, 182-7(Jul 1972).

The ratio of the cross sections of the reaction A(p,dp)A−2 and d(p,d)p, the forward deuteron emission by the direct pick-up process in the high-energy proton–nucleus collision, depends on the ratio of the Fourier components of the short-range two-nucleon correlation function and the deuteron wavefunction. The momentum dependence of the latter ratio is discussed in detail and it is concluded that the characteristics of the correlation function can be informed even by the qualitative behavior of the former ratio. The distortion of the incident and outgoing waves is described only by an energy-insensitive multiplicative factor, and does not affect the above conclusion. (auth)

1693 BOUNDARY CONDITION PARAMETER IN R-MATRIX THEORY. Barker, F. C. (Australian National Univ., Canberra). Aust. J. Phys.; 25: No. 4, 341-8(Aug 1972).

In the general R-matrix theory of nuclear reactions, all measurable quantities such as the cross sections $\sigma_{cc'}$ should be independent of the choice of the boundary condition parameters B_c although the values of the level parameters E_λ and $\gamma_{\lambda c}$ depend on the B_c. For applications involving only a finite number of levels λ, it is not obvious that this is still the case as completeness arguments can no longer be used. It is shown that $\sigma_{cc'}$ can be made independent of the choice of B_c for any finte number of levels and any number of channels, and the resulting formulae giving the dependence of E_λ and $\gamma_{\lambda c}$ on B_c are derived. An application is made to the pair of $5/2^{-}$ levels of ^{7}Li near 7 MeV excitation. (auth)

1694 DENSITY-DEPENDENT EFFECTIVE INTERACTIONS IN FINITE NUCLEI. I. Nemeth, J. (Institut de Physique Nucleaire, Orsay, France); Ripka, G. Nucl. Phys.; A194: No. 2, 329-52(1972).

Finite nuclei ranging from ^{16}O to ^{208}Pb are calculated using the Hartree–Fock theory and the local-density approximation. The energy of the nucleus is separated into a volume term, which can be calculated directly in terms of the nuclear matter energy density, and a residual surface term which contains a starting energy correction and to which only the long-range part of the effective interaction contributes. The results obtained are compared with experiment and with other calculations. (auth)

1695 SPHERICAL NUCLEI IN THE LOCAL DENSITY APPROXIMATION. Campi, X. (Institut de Physique Nucleaire, Orsay, France); Sprung, D. W. Nucl. Phys.; A194: No. 2, 401-42(1972).

Hartree–Fock calculations have been performed for the closed-shell nuclei ^{4}He, ^{16}O, ^{40}Ca, ^{48}Ca, ^{90}Zr, and ^{208}Pb, using the density-dependent effective interaction of Sprung and Banerjee. Over-all good results were obtained when the force is adjusted to saturate nuclear matter with −16.5 MeV energy at $k_F = 1.35$ fm^{-1}. The influence of saturation properties, compressibility and symmetry energy upon the finite-nucleus results is studied. The neutron-rich isotopes of He up to A = 10 and O up to A = 30 are also considered. (auth)

1696 OBSERVABLE MANY-BODY EFFECTS OF THE TWO-BODY UNOBSERVABLE POTENTIAL. Wong, N. N.; Razavy, M. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 14, 1614-6(15 Jul 1972).

A two-body transparent potential, which produces no observable phase shift in two-particle scattering, is constructed explicitly. This potential is used to calculate the energy of infinite nuclear matter by applying the perturbation theory and its effects on the many-body system are investigated. (auth) (Canada)

1697 EQUATIONS FOR LINKED CLUSTERS AND BRUECKNER-BETHE THEORY. Luehrmann, K. H.; Kuemmel, H. (Ruhr Univ., Bochum, Ger.). Nucl. Phys.; A194: No. 2, 225-36(1972).

Explicit correspondence between the Goldstone expansion and equations for linked clusters (derived by the exp(S) method) is obtained by iterating the equations. It is seen that the (bubble insertion) off-shell particle potential to all orders can be obtained quite naturally by iterating the two- and three-body equation. Questions of the on-shell potentials and of the treatment of exchange are discussed. (auth)

1698 METHOD FOR A CALCULATION OF THE NUCLEAR CRITICAL CHARGE. Popov, V. S. (Inst. of Theoretical and experimental Physics, Moscow). Yadern. Fiz.; 15: No. 5, 1069-81(May 1972). (In Russian).

A simple formula is given for the nuclear critical charge. The formula is asymptotically exact at the condition $R \ll \hbar/(m_e c)$ where R is the nuclear radius. The dependence of the critical charge Z_c on R, on a character of the charge distribution inside

the nucleus, etc., is investigated by the use of this formula. Perturbation theory for Z_c is considered. (auth)

1699 EXAMINATION OF DISTORTED WAVE METHOD FOR STRIPPING REACTIONS TO RESONANT STATE. Bunakov, V. E.; Gridnev, K. A.; Krasnov, L. V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 15: No. 5, 906-16(May 1972). (In Russian).

A numerical test of a modified distorted wave method applicability for stripping reactions to resonant states was carried out. The results obtained show that the accuracy of the proposed method is not worse than the accuracy of the usual distorted wave method for resonances with width $\Gamma \leq 1$ MeV. (auth)

1700 DENSITY OF PARTICLE-HOLE EXCITED STATES IN SHELL MODEL. Ignatyuk, A. V.; Sokolov, Yu. V. Yadern. Fiz.; 16: No. 2, 277-83(Aug 1972). (In Russian).

The calculations of thermodynamic characteristics of nucleus with a fixed number of excited particles and holes have been made for single particle levels of the shell model. The dependence of those on the state of shell filling is studied. Due to shell effects the density of particle hole states of magic nuclei differs greatly from the predictions of simple models. (auth)

1701 USE OF K-HARMONICS METHOD FOR SPIN-ORBIT SPLITTING CALCULATIONS OF LIGHT NUCLEI. Baz, A. I.; Gorbatov, A. M.; Demin, V. F.; Pokrovskii, Yu. E.; Rogov, Yu. K. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 16: No. 2, 321-5(Aug 1972). (In Russian).

The value of matrix elements for spin-orbit NN interaction ($K = K_{min}$) is given for nuclei with one excess or one missing nucleon in outer shell. By the numerical method it is shown that LS potentials, obtained from NN scattering data, are in accordance with the data on spin-orbit splitting for light nuclei. (auth)

1702 EXCITATION OF NUCLEAR VIBRATIONAL LEVELS BY ELECTRONS IN α-PARTICLE MODEL. Antonov, A. N.; Inopin, E. V. (Kharkov State Univ.). Yadern. Fiz.; 16: No. 2, 326-31(Aug 1972). (In Russian).

It is shown that, in the framework of α-particle model of a nucleus, one may achieve satisfying results in the description of excitation of vibrational levels with electrons in assumption that the vibrations possess the strong anharmonicity. This anharmonicity is connected with a relatively low binding energy of α-particle in a nucleus. It is exhibited that considering the vibrational degrees of freedom in assumption of strong anharmonicity, one reaches a good agreement between theory and experimental data on elastic scattering and on scattering with excitation of rotational levels. (auth)

1703 METHOD FOR COUPLED-CHANNELS CALCULATIONS. Boisson, J. P.; Gignoux, C. (Univ., Grenoble, France). J. Phys. (Paris); 33: No. 2-3, 183-7(1972). (In French).

A matrix method based on Kapur–Peierls eigenstates is proposed for the coupled-channel calculations involved in scattering and bound-state problems. The method is illustrated for the bound-state problem in the deformed Saxon–Woods potential. Some results obtained in the framework of the three-body problem are presented. (France)

1704 NON-INVARIANCE OF DISTRIBUTIONS OF REACTION MATRIX PARAMETERS UNDER CHANGES IN BOUNDARY CONDITIONS. Bertram, W. K.; Cook, J. L. (Australian Atomic Energy Commission, Sutherland). Aust. J. Phys.; 25: No. 4, 349-59 (Aug 1972).

Contrary to current opinion, the statistical distributions of level spacings and reduced widths when applied to the reaction matrix are not invariant under changes in the boundary condition matrix or the matching radius. General arguments are given, together with specific examples which violate the invariance requirements. It is concluded that it may be the parameters of the collision matrix which should be analyzed and considered as the invariant parameters. It is shown that if, for a specific set of boundary conditions, the distributions of level spacings and reduced widths are uncorrelated, then correlations between the level spacings and widths must exist when different boundary conditions are used. (auth) (Australia)

1705 NONCENTRAL EFFECTS IN TWO-NUCLEON TRANSFER REACTIONS. Dobes, J. (Nuclear Research Inst., Rez, Czech.). Czech. J. Phys.; 22: No. 10, 874-82(1972).

Using general forms of the bound tri-nucleon wave function including S′- and D-components and of the two body interaction containing the tensor force, noncentral effects in two-nucleon transfer reactions of the type (t,p) or (^{3}He,p) are investigated. The discussion suggests that noncentral effects could play an important role in these reactions. The central and noncentral parts contribute coherently in certain cases in the expression for the differential cross section even if the spin-independent optical potentials are used. (auth)

1706 EFFECT OF LOW-LYING COLLECTIVE STATES ON THE STRUCTURE OF GIANT RESONANCES. Zhivopistsev, F. Z.; Lukashov, V. A.; Shitikova, K. V.; Yudin, N. P. (Moscow State Univ.). Czech. J. Phys.; 22: No. 10, 883-9(1972).

The influence of coupling of the usual particle-hole states to particle-hole states built on a collective state has been estimated. Numerical calculations are performed for ^{60}Ni, ^{90}Zr, and ^{208}Pb. (auth)

1707 DIRECT FISSION OF HEAVY NUCLEI BY IONS. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B3: No. 4, 499-511(1972). (In Russian).

A model is formulated for fission in heavy ion reactions. This model includes the fission channel of a compound nucleus, in accordance with the statistical theory, as well as a new channel of direct fission occurring without the stage of the compound nucleus production. (auth)

1708 TERNARY FISSION IN COMPOUND NUCLEUS REACTIONS. Kalinkin, B. N.; Permyakov, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol.; B3: No. 4, 485-91(1972). (In Russian).

Interpretation of ternary fission is suggested. The proposed model makes it possible to explain the cross-section value, its dependence on energy, and tendency to fission into the fragments of comparable mass. (auth)

1709 ANGULAR DISTRIBUTION OF PRODUCTS OF DIRECT NUCLEAR REACTION A(a,b)B. Kozlowski, M. (Univ., Warsaw). Acta Phys. Pol.; B3: No. 4, 421-6(1972).

Formulas for the angular distribution and its asymmetry are presented. The expansion of the angular distribution and its asymmetry into Legendre polynomials provides information about the contribution of the selected partial amplitudes to the asymmetry of the angular distribution. The restriction on the asymmetry coefficient $A(\theta)$ which follows from isospin conservation in the reaction A(a,b)B is also presented. (auth)

1710 SUM RULES FOR MANY-PARTICLE MATRIX ELEMENTS IN THE SENIORITY SCHEME. Nomura, Masao (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 6, 1858-77(Jun 1972).

Sums of squares of many-particle matrix elements over all the quantum numbers except seniority numbers are directly related to two-particle matrix elements of a particle-particle interaction and of the corresponding particle-hole interaction. (auth)

1711 SHELL EFFECTS IN BEHAVIOR OPTICAL POTENTIAL OF NUCLEI. Kashuba, I. E.; Kotishevskaya, E. Yu. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 4, 635-9(Apr 1972). (In Russian).

On the basis of calculations for differential cross sections of 1.5 and 4 MeV neutron elastic scattering by nuclei, parameters of the optical potential are analyzed in a wide range of atomic numbers which takes into account surface absorption. The values of the optical potential real part fluctuate near the straight line $V_0 = V_0^{(0)} - V_0^{(1)} \cdot (N-Z)/A$, reaching maximum values in case of nuclei magic with respect to neutrons. (auth)

1712 COULOMB INTERFERENCE IN THE HALF-SHELL t-MATRIX DERIVED FROM THE HAMADA–JOHNSTON POTENTIAL. McCarthy, I. E.; Tandy, P. C. (Flinders Univ. of South Australia, Bedford Park). Aust. J. Phys.; 25: No. 3, 237-46 (Jun 1972).

The calculation of the half-shell two-nucleon t-matrix from the wavefunction due to the Hamada–Johnston potential in the presence of the Coulomb interaction is described. The contribution from the long range nature of the Coulomb interaction is included and its effect on the half-shell t-matrix is indicated. (auth) (Australia)

1713 AVERAGE ONE-BODY OPERATORS WITH FIXED ANGULAR MOMENTUM AND SENIORITY. Ginocchio, J.; Yen, M. M. (Yale Univ., New Haven). Contract AT(11-1)-3074. Nucl. Phys.; A195: No. 1, 129-45(1972).

A simple method using the group properties of quasi-spin is derived to compute the average of one-body operators with fixed seniority and angular momentum. The average reduced matrix elements of the one-body operators for n identical nucleons in an orbital with angular momentum j are calculated for $j \leq 15/2$ and tabulated for $j \leq 11/2$. (auth)

1714 FINITE SIZE EFFECTS IN HEAVY ION SCATTERING. Mosel, Ulrich (Univ. of Washington, Seattle). Particles Nucl.; 3: No. 6, 297-317(Jun 1972).

A Hamiltonian for the description of scattering of particles with

finite size has been derived by using methods common in fission theory. It is pointed out that in a rigorous treatment of heavy ion interactions information about the true potential can be obtained from experimental data only if the inertial parameters are known. In general the inclusion of the finite size of the scattered particles leads to an explicitly energy and angular momentum dependent real potential when the finite size Hamiltonian is reduced to an optical model form. In a phenomenological model estimate it is shown that the observed energy dependence of the optical potential is compatible with the magnitude of finite size effects. Finally some difficulties in the use of the cranking model for the calculation of the inertial parameters are pointed out. (auth)

1715 UNNATURAL-PARITY AMPLITUDES FROM EXCHANGE EFFECTS IN A LOCAL ENERGY APPROXIMATION. Love, W. G. (Univ. of Georgia, Athens). Particles Nucl.; 3: No. 6, 318-31(Jun 1972).

A "local" energy approximation for the unnatural-parity amplitudes arising from knock-on exchange effects is developed for the inelastic scattering of both nucleons and composite particles ($A \leq 4$). The result is an effective velocity-dependent potential having simple unnatural-parity matrix elements. The approximation is compared with exact calculations for nucleons. The result for composite particles is applied to the inelastic excitation of unnatural-parity states by α-particles and to the excitation of 0^+ antianalog states in (He-3,t) reactions. (auth)

1716 POSSIBLE INTERPRETATION OF COLLECTIVE MODES IN FISSION PROCESS. Kuratsuji, Hiroshi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 6, 1844-57(Jun 1972).

In the final stage of fission, the fissioning nucleus can be described by two nuclei in close proximity. The Hamiltonian of the system at this stage can be expressed as the sum of the Hamiltonians of two independent fragments and coupling terms between them. The coupling terms are, roughly speaking, divided into two types: (i) particle transfer type and (ii) density-density type. By making use of extremely schematic models, the relation between the collective modes and the coupling terms is investigated. As for the particle transfer correlation it is shown that the monopole-monopole type interaction leads us to the asymmetric mass division in low energy fission. Furthermore it is discussed that the angular vibrational mode, which is associated with the angular orientations of fragments, is derived from the quadrupole-quadrupole interaction. (auth)

1717 PION PHOTOPRODUCTION ON QUASI-FREE NUCLEONS IN NUCLEI. Laget, J. M. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A194: No. 1, 81-102(1972).

A theoretical evaluation of the $A(\gamma,p\pi^-)B^*$ reaction cross section is given, when the recoil nucleus momentum P_r is small; the impulse approximation and the shell model are used. The influence of the remaining nucleons on the elementary process $\gamma + n \rightarrow p + \pi^-$ is studied. Two kinds of effects are relevant. Firstly the final-state distortion effects lead to a nearly constant nonnegligible attenuation of the plane-wave cross section. Secondly they lead to a polarization effect on the target nucleon; however this latter effect appears to be small. Numerical evaluations of the $^4He(\gamma,p\pi^-)$ and $^{12}C(\gamma,p\pi^-)$ reaction cross-section values are given. They appear to be stable with respect to the variation of the parameters which enter the calculation, when they are chosen to reproduce the gross structure of the nuclei. (auth)

1718 ODD-EVEN EFFECTS IN COULOMB DISPLACEMENT ENERGY. Nir, D. (Hebrew Univ., Jerusalem). Nucl. Phys.; A194: No. 1, 103-12(1972).

A new form of data analysis is used to extract the net odd-even effect in the Coulomb displacement energy. Various types of model-independent second differences of the quantity $A^{1/3}(\Delta E_c)$ are studied. The observed oscillatory behavior is interpreted as resulting from Coulomb pairing effects. The contribution of the latter is calculated by counting the pairs in the independent-particle model wave functions. The pairing term is included explicitly and makes it possible to present new mass and Coulomb displacement energy relationships. (auth)

1719 APPLICATION OF THE CLUSTER MODEL TO ^{12}C AND ^{36}Ar NUCLEI. Rusev, R. P. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 4, 463-6(1972). (In Russian).

Attempts have been made to generalize the several types of models used to describe nuclei into the cluster model which may be considered both as the isolation of α particles in light nuclei and the interchange of nucleons between them. The analogous model is here considered in relation to the nuclei ^{12}C and ^{36}Ar, inert cores with completed shells plus α-holes in the incompleted shell. (K.S.W.)

1720 ROTATING SINGLE-PARTICLE EXCITED STATES OF ODD–ODD NONAXIAL NUCLEI WITH $J_p = J_n = 1/2$. Giyazov, I.; Latipov, A. Sh.; Sharipov, Sh. (Tashkent State Univ.). Dokl. Akad. Nauk Uzb. SSR; No. 4, 24-7(1972). (In Russian).

The excited states of odd–odd nonaxial nuclei having $j_p = j_n = 1/2$ were investigated without separating the excitation into collective and single-particle excitation. The model assumed was a system consisting of a core of all even nucleons, the equilibrium form of which corresponded to an ellipsoid of rotation, and two external nucleons (an off proton and an odd neutron). The results of the theoretical calculations were compared with experimental data for ^{174}Lu, ^{186}Re, and ^{188}Re. (K.S.W.)

1721 THEORY OF QUASI-ELASTIC SCATTERING OF ELECTRONS BY NUCLEI. Vagradov, G. M.; Gorchakov, V. V. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 680-5(Mar 1972). (In Russian).

The methods of many-body field theory were used for describing electron scattering by nuclei. The general picture of quasi-elastic scattering of electrons could be qualitatively explained. By way of illustration, the cross section of quadrupole scattering of electrons by ^{12}C was calculated, resulting in the appearance of 1s- and 1p-peaks which represent knock-out of 1s- and 1p-protons, respectively, and the envelope of the two curves represents the total cross section. (K.S.W.)

PHYSICS (PLASMA AND THERMONUCLEAR)

1722 NATURE OF BALL LIGHTNING. Trubnikov, B. A. (Inst. of Atomic Energy, Moscow). Dokl. Akad. Nauk SSSR; 203: No. 6, 1296-8(1972). (In Russian).

The Dawson–Jones model (1969) of ball lightning is a cavity enclosed by a plasma shell within which characteristic electromagnetic oscillations are excited, and whose pressure is equilibrated with that of the external atmosphere. A series of modifications are presented that offer greater realism to such a model. A decrease of the characteristic wavelength from centimeters to millimeters or even to the submillimeter range is suggested. The motion of ball lightning, pressure within the ball, and its shell structure are also discussed. (K.S.W.)

Confinement and Heating

Refer also to abstract 1770.

1723 (LA-5010) MULTIPLE-PASS LASER HEATING OF A MAGNETICALLY CONFINED PLASMA. Humphries, Stanley Jr. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 5p. Dep. NTIS.

If the plasma to be heated is placed inside the optical cavity of a laser, a multiple-pass system allowing on the order of 100 passes through the plasma can result. Plasma conditions necessary to assure a stable cavity are derived. An experiment is described in which it is expected to significantly raise the temperature of plasma produced in a z-pinch entirely by inverse bremsstrahlung. It may be possible to use the plasma to Q-switch the laser to make more-efficient use of the available energy. (auth)

1724 (NRL-Memo-2502) NON-THERMAL PROCESS IN A LINEAR PINCH DEVICE. Lee, T. N. (Naval Research Lab., Washington, D. C.). Sep 1972. 8p. (CONF-720710-7).

From 2nd topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

A low-pressure, linear discharge initiated by focusing a pulsed laser beam between two electrodes produces a concentrated thermal plasma of $T_e \approx 8$ keV and $N_e \approx 10^{21}$ cm^{-3}. This plasma emits x-ray line radiation that arises from highly stripped atoms such as hydrogen- and helium-like iron ions. The temperature of the Fe XXV ion, estimated from Doppler line broadening, is higher than the electron temperature, in agreement with the results obtained by Peacock, et al. The heating mechanism for attaining such high temperatures during the very short periods of interest is considered, and some experimental results supporting the contribution to the plasma heating by a nonthermal process are presented. (auth)

1725 (UCB-34-P-128-X-2) HEATING OF MAGNETIZED PLASMAS BY A LARGE-AMPLITUDE LOW-FREQUENCY ELECTRIC FIELD. Chen, Liu; Birdsall, C. K. (California Univ., Berkeley. Electronics Research Lab.). Jun 1972. Contract AT-(04-3)-34. 43p. (ERL-M-352). Dep. NTIS.

Plasma electron and ion heating due to a large-amplitude oscillating electric field E_0 applied normal to a steady magnetic field B_0 was followed in detail by one-dimensional computer simulations. The large oscillating drift velocity ($E_0/B_0 > v_e$) at low frequency ($\omega_{ci} \ll \omega_0 \simeq \omega_{pi} \ll \omega_{ce}$) sets up instabilities due to the periodic electron E/B drift through the ions, which then cause rapid heatings. For waves propagating across $\vec{B}_0$ ($\vec{k} \cdot \vec{B}_0 = k_{||} = 0$), the instability is a Buneman-type upper-hybrid two-stream instability. Electron perpendicular thermal velocity is increased to $\sim E_0/B_0$ with little ion heating. For obliquely propagating waves ($k_{||} \neq 0$), there is an additional instability, the modified two-stream instability. For small $k_{||}$ (roughly, $k_{||}/k \lesssim \sqrt{m_e/m_i}$), the upper-hybrid instability dominates and the heating is similar to the $k_{||} = 0$ case but with a small amount of electron parallel heating. As $k_{||}$ increases, however, the modified two-stream instability becomes dominant. Electron parallel thermal velocity is increased to $\simeq (E_0/B_0)(k/k_{||})$. Strong ion (perpendicular) heating also occurs with the ion thermal velocity at wave saturation near (E_0/B_0)-$(m_e/m_i)^{1/4}(k/k_{||})^{1/2}$. Comparison with similar work with $B_0 = 0$ shows that addition of B_0 is best for ion heating, improving KT_i by $(m_i/m_e)^{1/2}$. Possible applications of these results to laboratory experiments are also discussed. (auth)

1726 ALTERNATIVE DESCRIPTION OF LASER PLASMA HEATING FOR SPHERICAL THERMAL WAVES, THE FUSION ENERGY BEING TAKEN INTO ACCOUNT. Kaliski, S. (Inst. of Fundamental Technological Research, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 5, 381-7(1972).

The expression and solution of equations for conductivity-type laser heating of plasma are presented, taking into consideration the energy of thermonuclear fusion and using the averaged description. The alternative descriptions lead, if one passes to the plane problem, to an agreement with the averaged equations as obtained by the method of momentums. (auth)

1727 AVERAGED EQUATIONS FOR JOINT TREATMENT OF HYDRODYNAMIC EXPANSION AND CONDUCTION-TYPE HEATING OF PLASMA, THE ENERGY OF NUCLEAR FUSION BEING TAKEN INTO CONSIDERATION. PART II. SPHERICAL PROBLEM. Kaliski, S. (Inst. of Fundamental Technological Research, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 5, 389-93(1972).

The equations of Part I are generalized to the case of spherical and cylindrical symmetry for joint averaged description of the hydrodynamic expansion and the conduction-type laser heating of plasma. The equations obtained differ from those of the plane problem by the structure of the second of the equations of momentums. (auth)

1728 NEOCLASSICAL PLASMA TRANSPORT IN NEARLY AXISYMMETRIC TOROIDAL SYSTEMS. Glasser, Alan Herbert. San Diego, Calif.; Univ. of California (1972). 208p. University Microfilms Order No. 72-25,732.

Thesis.

All of the neoclassical transport processes are calculated for a general axisymmetric torus. A small Larmor radius expansion of the Fokker–Planck equation yields the equilibrium in first order, the drift kinetic equation in second order, and the mass and energy transport equations in third order. A coordinate-free solution procedure based on the abstract theory of scalar products eliminates the use of the scalar magnetic potential and allows the treatment of non-vacuum magnetic fields. The transport coefficients in the banana regime for an axisymmetric torus with a small fraction of trapped particles are evaluated by a generalization of the variational technique of Rosenbluth, Hazeltine and Hinton, including the effects of like-particle collisions. Differently shaped systems are found to be characterized by certain geometric factors which are found, and these are calculated numerically for the particular case of the Gulf General Atomic Doublet II. The superbanana fluxes arising from small nonaxisymmetric perturbations are calculated, and effects of a failure of the magnetic field to form closed surfaces are investigated. (Diss. Abstr. Int., B)

1729 HIGH-FREQUENCY HEATING OF A PLASMA UNDER CONDITIONS OF ION–ION HYBRID RESONANCE. Tarasenko, V. F.; Ovchinnikov, S. S.; Kalinichenko, S. S.; (and others). JETP Lett. (USSR) (Eng. Transl.); 16: No. 3, 114-16(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 165-7(5 Aug 1972).

High-frequency heating of plasma in close magnetic traps is a problem in controlled thermonuclear fusion. Experimental results are reported of heating a plasma consisting of a mixture of hydrogen and deuterium ions in the Omega device, with a toroidal magnetic field that is uniform along the axis under conditions of ion–ion hybrid resonance. The conclusions drawn are that (1) effective excitation of waves in a dense plasma situated in a toroidal magnetic field is possible in the region of ion–ion hybrid resonance; (2) by choosing the length of the wave excited in the plasma and the relative concentrations of the working gases it is possible to ensure penetration of waves into a dense plasma in a wide range of experimental conditions; and (3) the ions of a dense three-component plasma could be heated along the entire length of the torus when resonance conditions were satisfied near the axis of the plasma filament; the gas-kinetic pressure of the plasma under the experimental conditions reached values $nT \simeq 10^{16}$ eV/cm^3 at a plasma density $n \simeq 10^{14}$ cm^{-3}. (J.C.W.)

1730 EXPERIMENT ON MAGNETOSONIC HEATING OF IONS IN THE TOKAMAK TO-1. Ivanov, N. V.; Kovan, I. A.; Kozlov, L. I.; Los, E. V.; Svishchev, V. S.; Shvindt, N. N. JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 60-2(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 88-91(20 Jul 1972).

A self-excited oscillator based on a GI-41 tube was used to heat the plasma. The hf generator was turned on during a macroscopically stable stage of the discharge when the plasma concentration exceeded 10^{13} cm^{-3}. Measurements of ion heating during introduction of the hf energy are described. (M.O.W.)

1731 HIGH-FREQUENCY PLASMA HEATING IN A TOROIDAL TRAP. Voloshko, A. Yu.; Vitsenya, V. S.; Longinov, A. V.;

(and others) (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 54-7(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 80-3(20 Jul 1972).

The possibility of effectively introducing hf energy into the plasma by using a system that produces on the plasma periphery a spatially periodic hf field E_z parallel to the confining magnetic field is discussed. Preliminary results are presented on plasma heating in the metallic chamber of the Saturn toroidal stellarator-torsatron. When slow waves are excited in a plasma of density 10^{10} cm^{-3} in the frequency band $\omega_h \geq \omega > \omega_{Hi}$ (where ω_h and ω_{Hi} are the lower hybrid and the ion-cyclotron frequencies), an appreciable heating is observed. (M.O.W.)

1732 PLASMA HEATING IN CLOSED MAGNETIC TRAPS BY INJECTION OF FAST NEUTRAL ATOMS. Nezlin, M. V. (Inst. of Atomic Energy, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 78-80(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 112-14(20 Jul 1972).

It is shown that the replacement of hydrogen atoms by lithium atoms having the same energy makes this plasma heating method much more effective and preferable for use in existing experimental setups and in those under construction. The effectiveness of this method of plasma heating is theoretically described. (M.O.W.)

1733 AVERAGED EQUATIONS OF LASER HEATING OF PLASMA IN A FOCUS-TYPE SYSTEM, TAKING INTO ACCOUNT THE HEAT OF NUCLEAR FUSION. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 6, 123-31(1972).

Averaged equations are derived for laser heating of plasma in a focus system, with consideration of the energy of thermonuclear fusion. In the case of a special simplification for short laser impulses and the initial stage of expansion of the plasma focus, the title equations become, with some modifications, those of laser heating of plasma in a z pinch, taking into account the heat of nuclear fusion. The case considered is that of one-temperature plasma. Though rough due to neglecting a number of effects, the averaged equations enable one to appraise this extremely complicated process by relatively simple means and, on the other hand, give a point of departure for the investigation into this promising mechanism of nuclear microfusion if higher plasma densities may be achieved. (auth)

1734 AVERAGED EQUATIONS OF LASER HEATING OF TWO-TEMPERATURE PLASMA IN A FOCUS-TYPE SYSTEM, TAKING INTO ACCOUNT THE HEAT OF NUCLEAR FUSION. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 6, 133-8(1972).

In the particular case of a laser impulse which is very short as compared with the duration of plasma flow through the focus region and at the initial stage of expansion the equations obtained become those of the analogous problem of z pinch with certain modifications following from the physical model of the process assumed. Despite some far-going simplifications of qualitative and quantitative nature the averaged equations enable an appraisal of this extremely complicated process and constitute a point of departure for the investigation of the mechanism with which nuclear microfusion may be achieved for higher densities of plasma in the future. (auth)

Diagnostics

1735 (LA-5058) HOLOGRAPHIC INTERFEROMETRY COOKBOOK. Jahoda, F. C.; Siemon, R. E. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 18p. Dep. NTIS.

Various approaches to pulsed holographic interferometry are described and reasons are given for preferring nondiffuse holograms which contain on the hologram an image of the plasma. Many details often omitted from more formal publications are given concerning laser requirements, optical components, recording materials, and so on. A discussion is given of the interpretation of plasma interferograms in which it is emphasized that interferometric data is very useful quantitatively as well as qualitatively. (auth)

1736 (NP-19480) HOLOGRAPHIC INTERFEROMETRY IN A VIBRATING ENVIRONMENT. Rijnhuizen Report 72-70. Kuepper, F. P.; Mastop, W. J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Jun 1972. 18p. Dep. NTIS (U. S. Sales Only).

The interferometric measurement of the index of refraction of a transparent-phase object with conventional interferometers is impossible if the optical paths are disturbed by vibrations of the components before or during the measurement. In the case of transient-phase objects this problem can be solved by the application of holographic interferometry using a giant pulse ruby laser. That laser emits two light pulses, one before and one during the appearance of the phase object. The method is employed to detect the integral of the electron density of a plasma in a toroidal arc experiment. (auth)

1737 CONTINUUM ELECTROSTATIC PROBE THEORY WITH MAGNETIC FIELD. Niyogi, Kalyan Kumar. Philadelphia; Univ. of Pennsylvania (1972). 94p. University Microfilms Order No. 72-25,641.

Thesis.

A continuum electrostatic probe theory is developed for a slightly ionized, collision-dominated plasma in the presence of a uniform magnetic field. Due to the anisotropy of the diffusion coefficient arising out of the gyration of charged particles about the magnetic lines of force and causing their drift motion at different rates along and across the magnetic field, the problem needs at least a two-dimensional treatment. The equations governing the problem are derived and they are coupled and nonlinear. The approaches to the analytical solution show that even in some special cases a complete analytical solution is practically impossible. A quasilinearization technique is applied to solve the governing equations numerically using finite difference approximations, in the case of spherical probes larger than the Debye length, the magnetic field being weak. When the probe size is not very large or the probe potential is small, the detailed analysis of the sheath is not necessary. But when the probe potential is large, the sheath needs a separate treatment. The sheath equations are essentially one-dimensional and the magnetic field parameters do not appear explicitly. In the absence of an analytic solution for either sheath or the main region, both solutions are matched numerically in an overlap region. The theory and the numerical technique are also extended for ellipsoidal probes with the axis of revolution in the direction of magnetic field. (TSS) (Diss. Abstr. Int., B)

1738 MEASUREMENT OF ELECTRON DISTRIBUTION FUNCTION IN A CESIUM PLASMA. Chen, C. J. (Jet Propulsion Lab., Pasadena, Calif.); Wu, James; Wu, Frank. J. Appl. Phys.; 43: No. 11, 4570-3(Nov 1972).

A conventional plane Langmuir probe with dc superimposed on a small sinusoidal signal is used to measure the electron-energy distribution in a cesium discharge tube. The current-voltage characteristics and its second-derivative characteristics are obtained for various discharge conditions. The electron-energy distribution at different gas-particle densities and electric fields in the positive column are calculated. The deviation from a Maxwellian distribution is observed for a low gas density and high electric field plasma. The calculation of the distribution function is also carried out by solving numerically the Boltzmann equation with electric field, including the effects of the elastic and inelastic collisions. (auth)

1739 PLASMA AND GASEOUS DIAGNOSTICS WITH A TUNED GaAs LASER DIODE. Ku, R. T.; Verdeyen, J. T.; Cherrington, B. E.; Goldstein, L. (Univ. of Illinois, Urbana). J. Appl. Phys.; 43: No. 11, 4579-86(Nov 1972).

This paper demonstrates that the classical gaseous diagnostic techniques of resonant absorption, anomalous dispersion interferometry, and resonant scattering can be performed with considerable ease utilizing a tunable GaAs diode laser. Absorption measurements of ^{133}Cs in the ground state were performed by matching the GaAs laser emission to the 8521 Å transition ($6^2S_{1/2} \rightarrow 6^2P_{3/2}$). The measured number density of Cs in the ground state is in general agreement with the value obtained from the known vapor pressure of cesium. The same type of measurements were also made for the $1s_2$ and $1s_4$ resonant states in an argon plasma by tuning the laser to the 8408 Å and 8424 Å lines, respectively. In addition, interferometry studies using the swept GaAs laser are also reported here for the first time. These studies were carried out simultaneously with the absorption measurement for the same $1s_2$ and $1s_4$ states in the argon discharge. The number densities of argon atoms in these states as obtained by both methods are in reasonable agreement. (auth)

1740 FAR-INFRARED PLASMA REFLECTOMETRY AND INSTABILITY DETECTION. Jassby, D. L.; Marhic, M. E. (Univ. of California, Los Angeles). J. Appl. Phys.; 43: No. 11, 4586-90(Nov 1972).

A focused cyanide laser beam at 337 μ is used to study a steady-state highly ionized plasma column operating at densities up to 1.5×10^{16} cm^{-3} in an axial magnetic field up to 10 kG. A reflectometer measures the energy reflected from the cutoff layer. A strong coherent m = 1 instability in the plasma is detected by amplitude

modulation of either an off-axis transmitted beam or an on-axis reflected beam. This technique allows electrodeless probing of the stability characteristics of a high-energy-density plasma. (auth)

Kinetics (General)

Refer also to abstracts 1195 and 1724.

1741 (AD-740570) RADIATION STUDIES OF ARC-HEATED PLASMAS. Final Report, January 1970-July 1971. Morris, J. C.; Yos, J. M. (Avco Corp., Wilmington, Mass. Avco Systems Div.). Dec 1971. Contract F33615-70-C-1360. 617p. (AVSD-390-71-CR; ARL-71-317). NTIS.

The report presents tables of the continuum radiation from argon, nitrogen, oxygen, and air in the spectral range from 950A to 6.0 μ, for temperatures from 9000 to 30,000°K and pressures from 1 to 30 atm. For the neutral atoms and singly charged ions, these tables are based on the authors previously reported experimental data, while for doubly charged ions, they are based on new quantum defect calculations of the radiation. Also included in the report are tables of the Stark widths and shifts for singly ionized argon lines at temperatures from 15,000 to 25,000°K, as calculated from Griem's semi-empirical treatment. These results are compared with experimental data on the Stark shifts of several Ar II lines at 20,000°K, which were measured in the pulsed argon arc. (auth) (GRA)

1742 (AD-818632) PLASMA KINETIC ENERGY-RF CONVERSION. Final Report on Phase 4. Waniek, R. W.; Fleischman, T. H.; Savoie, W. R.; Hsu, J. S.; Grannan, R. T. (Advanced Kinetics, Inc., Costa Mesa, Calif.). Jul 1967. Contract AF30(602)-4169. 97p. (RADC-TR-67-270). NTIS.

The report describes a theoretical and experimental investigation of rf emission from a magnetized plasma. Very intense bursts of microwave energy were measured from a high energy discharge through a PIG type magnetic field configuration. Peak powers above 1 kW were measured in pulses of X-band energy typically tens to hundreds of nanoseconds long. The experimental program is described and some theoretical explanations of the results are included. (auth) (GRA)

1743 (TRITA-EPP-72-13) COLLECTIVE PHENOMENA IN A PENNING DISCHARGE IN A STRONGLY INHOMOGENEOUS MAGNETIC FIELD. Hopfgarten, N.; Johansson, R. B.; Nilsson, B. H.; Persson, H. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). May 1972. 51p. Dep. NTIS (U. S. Sales Only).

In an attempt to study electric field components along the magnetic field in a collision-free plasma, to simulate the conditions in a geomagnetic flux tube, and to produce energetic ions, a pulsed Penning discharge was run in hydrogen gas of 1 to 40×10^{-4} torr pressure. Two cathodes were located in the mirrors and an anode in the midplane of a strongly inhomogeneous magnetic mirror field. Measurements of plasma particles, cathode heating, microwave emission, time-integrated light, diamagnetic and Langmuir probe signals, and of the electrical characteristics of the discharge were performed. The measurements show that there exists in the plasma body a potential difference of 1 to 2 kV, distributed along the magnetic field. The ion temperature in this region is 1 to 3×10^6°K. Under certain conditions a pronounced spatial variation of the neutral-particle emission is observed, suggesting a collision-free shock or sheath structure. Part of the ions are accelerated, probably by nonlinear waves, to energies (5 keV), exceeding what can be attained by electrostatic acceleration in the discharge. The distribution of these accelerated ions is monoenergetic. The various observations are interpreted in terms of certain collective phenomena in the discharge, namely: (a) a continuous parallel electric field, (b) a collision-free shock- or sheath-like structure, (c) a collision-free acceleration of ions by a laminar wave, (d) the possibility that this acceleration is a step in a collision-free transfer by waves of energy from electrons to ions, (e) the possible existence of an electron-laminar, ion-turbulent sheath, (f) an "anomalous" transport of electrons across the magnetic field, and (g) a number of modes of oscillation. A consistent overall picture of the discharge, the conditions for a shock/sheath formation, and the geophysical application are discussed. (auth) (Sweden)

1744 ION ACCELERATION ON EXPANSION OF A RAREFIED PLASMA. Gurevich, A. V.; Pariiskaya, L. V.; Pitaevskii, L. P. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 516-31(Aug 1972). (In Russian).

Acceleration of impurity ions of various masses and charges on expansion of a rarefied plasma into vacuum is investigated. Acceleration of the ions is produced by a self-consistent electric field arising during expansion of the plasma. It is shown that as a result of acceleration a considerable part of the impurity ions may acquire energies of the order of 10^2 to 10^3 T_e, where T_e is the plasma electron temperature. Excitation of self-similar and ion-sound waves is investigated. Results of numerical calculations are presented. (auth)

1745 SECOND HARMONIC GENERATION IN AN INHOMOGENEOUS LASER PLASMA. Vinogradov, A. V.; Pustovalov, V. V. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 940-50(Sep 1972). (In Russian).

Second harmonic coherent radiation emitted on incidence of an electromagnetic wave on a layer of an inhomogeneous plasma with a density exceeding the critical value is considered. It is assumed that the plasma temperature is so large that Coulomb collisions are negligible and the structure of the electromagnetic field near the critical point at the fundamental frequency is due to thermal motion of the electrons. Such conditions are encountered in a laser plasma with an electron temperature $T_e \gtrsim 1$ keV and a characteristic inhomogeneity size of 10^{-2} to 10^{-3} cm. In this case the coefficient for transformation of laser radiation into the second harmonic may reach 1% for optimal angles of incidence and for a power of $\sim 10^{13}$ W/cm^2. (auth)

1746 MEAN ENERGY, MOBILITY, AND ATOM-BREMSSTRAHLUNG OF ELECTRONS IN PARTIALLY IONIZED NONISOTHERMAL PLASMAS. Wojaczek, Karl (Zentralinstitut fuer Electronenphysik, Berlin). Beitr. Plasmaphys.; 11: No. 6, 511-22(1971). (In German).

An approximation technique of Kogan et al. (1969), determining the plasma-kinetic characteristics in the transition region between the negligible and the dominating electron interaction, is further developed. Relationships between the characteristic values and the electron temperature and the degree of ionization are given for the cases of energy-proportional and constant transfer cross sections. The resulting data have a particular importance for diagnosing medium-weak discharges. (IAA)

1747 NON-HYDRODYNAMIC PROPERTIES OF THE ELECTRON GAS IN THE PLASMA OF A DC DISCHARGE. Ruzicka, T.; Rohlena, K. (Inst. of Physics, Prague). Czech. J. Phys.; 22: No. 10, 906-19(1972).

The linearized one-dimensional Boltzmann equation was solved for the electron gas in the positive column of a low-current dc discharge. A sinusoidal perturbation of the electric field was assumed in the column and the perturbed distribution function was found. The problem was solved both numerically and approximately. It is shown that, in the absence of an electron-electron interaction, strong deviations from the solution of the hydrodynamic quasihomogeneous equations appear for certain wavelengths, which were called "resonant". These wavelengths almost exactly agree with the characteristic wavelengths of the ionization waves of the s- and p-variety. A physical interpretation of this resonant behavior is given and its relation to the long correlation length in a plasma with noninteracting electrons is pointed out. (auth)

Kinetics (Experimental)

1748 (NRL-Memo-2495) TWO-DIMENSIONAL HARD CORE THETA-PINCH OBSERVATIONS OF SPIRAL STRUCTURE ASSOCIATED WITH INITIAL BREAKDOWN. Duechs, D.; Dixon, R. H.; Elton, R. C. (Naval Research Lab., Washington, D. C.). 26 Jul 1972. 8p. (CONF-720710-6).

From 2nd topical conference on pulsed high-beta plasmas; Garching, Germany (3 Jul 1972).

The evolution of the luminous plasma structure in a hard-core θ pinch was studied in two dimensions (r,z). Distinct plasma spirals around the hard core are formed. In the antiparallel B_z-bias case the spirals coalesce due to a 3:1 axial compression. With zero bias field the plasma filaments are spiraling in the opposite sense of rotation. An axial structure of the plasma is observed to be present at the beginning of the main discharge. In the θ pinch without hard core this structure is shown to originate in the very initial preheater breakdown. (auth)

1749 DETERMINATION OF THE RADIAL DISTRIBUTION OF TEMPERATURE AND DENSITY OF CHARGED PARTICLES IN AN ELECTRODELESS DISCHARGE AT PRESSURES OF 1 TO 20 ATMOSPHERES. Mitin, R. V.; Pryadkin, K. K.; Zvyagintsev, A. V. Zh. Prikl. Spektrosk.; 16: No. 4, 599-604(Apr 1972). (In Russian).

Electrode-less discharges in Ar, Kr, and Xe were studied at 1 to 20 atm and at power levels up to 2.5 kW. Electron concentrations were determined in Ar and Kr by measuring the magnitude of the Stark widening of the H_β line after adding a trace of H_2; in Xe by measuring the broadening of the Xe I lines (4624 and 4671 Å) as a result of the quadratic Stark effect. The profiles of concentration, temperature, heat conductivities, and the intensity of

radiation in the visible region of the spectrum were determined. These profiles were used to solve energy balance equations and to account for radiation losses for different atoms and at various pressures. (tr-auth)

1750 RADIAL DISTRIBUTION OF FAST ELECTRON IN A Z PINCH. Presiantisev, I. G.; Pis'mennyi, V. D.; Rakhimov, A. T.; Starostin, A. N. (State Univ., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 45-8(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 68-72(20 Jul 1972).

The hydrogen discharge experiments have demonstrated the following: (1) The generation of fast electrons (above 100 keV); (a) is observed only after a series of "preconditioning" discharges and is not observed if the gas is even slightly contaminated, (b) occurs at the instant of the last of the series of "singularities" in the current (their total number is 3 to 4), (c) lasts from 60 to 150 nsec, and (d) appears and disappears simultaneously (within ~10 nsec) in all the emission regions. (2) The distribution of the fast electrons over the cross section of the discharge chamber: (a) is highly varied and is different for each discharge, (b) occupies an area from a fraction to several cm^2, (c) has as a rule approximately the same intensity within the limits of each clearly distinguished injection zone. Explanations of the phenomena are given. (M.O.W.)

Kinetics (Theoretical)

1751 (AD-740745) NONPHYSICAL SELF FORCES IN ELECTROMAGNETIC PLASMA-SIMULATION ALGORITHMS. Boris, J. P.; Lee, R. E. (Naval Research Lab., Washington, D. C.). Mar 1972. 14p. (NRL-MR-2418). NTIS.

A simple algorithm is described for removing nonphysical self forces from two popular electromagnetic plasma simulation models. This algorithm also has two additional features; it considerably reduces short-wavelength noise and unwanted numerical fluctuations, and permits faster integration of the particle orbit equations by roughly a factor of two. (auth) (GRA)

1752 (LA-DC-72-983) REVIEW OF COMPUTER STUDIES IN THE KINETIC THEORY OF FLUIDS. Wood, W. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. 48p. (CONF-720947-1). Dep. NTIS.

From Symposium on occasion of 100th anniversary of Boltzmann equation; Vienna, Austria (4 Sep 1972).

The role of computer studies in the kinetic theory of fluids is briefly reviewed, with emphasis upon the results for hard-core systems. After a short discussion of the advantages and limitations of computer methods, computer studies directly related to the Boltzmann equation, i.e., calculations of the one-particle distribution function f(r,v,t), by the methods of molecular dynamics and by numerical solution of the Boltzmann equation itself, are considered. A review of the molecular dynamics studies of time-correlation functions and the associated transport coefficients then follows. (auth)

1753 (SC-RR-720669) INTERACTION OF A RELATIVISTIC ELECTRON BEAM WITH A BOUNDED PLASMA. Poukey, J. W.; Toepfer, A. J. (Sandia Labs., Albuquerque, N. Mex.). Sep 1972. 29p. Dep. NTIS.

The return current induced in a cylindrically symmetric, uniform, bounded plasma of constant conductivity by the injection of a relativistic electron beam along the axis of symmetry is calculated. Cases with and without an applied longitudinal magnetic field are considered. The plasma is assumed to obey a generalized Ohm's law and the effects of beam dynamics are included. Quantitative studies of the effects of the displacement current, the inertial and Hall terms in Ohm's law, finite plasma radius, the existence of end plates in the system, and the finite rise time of the injected beam on the magnitude of the return current are made. (auth)

1754 QUASI-LINEAR THEORY OF PLASMA PLACED IN A WEAK UHF ELECTRIC AND CONSTANT MAGNETIC FIELD. Gradov, O. M.; Markeev, B. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 6, 832-9(1972). (In Russian).

A quasi-linear theory for a collisionless plasma placed in a weak uhf electric and constant magnetic field is developed. An equation was formulated that determines a change of the distribution function under the action of nonstationary oscillations. On its basis, a set of equations for the moments was obtained. An analytical solution of the quasi-linear equation system for the moments was found. It is shown that the system achieves the stationary state with the finite noise level. The time of settling the stationary state is determined. It is shown that the magnetic field may both slow down the process of settling the equilibrium and accelerate the plasma stabilization. (auth)

1755 ELECTRIC POTENTIAL AND PARTICLE CONCENTRATION OF A PLASMA IN THE VICINITY OF A RAPIDLY MOVING CHARGE. Dubovoi, A. P. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 951-7(Sep 1972). (In Russian).

Results of investigation of the track structure of a rapidly moving weak point charge Q are presented. At distances from the charge smaller than the Debye radius D but larger than $e|Q|/T$ analytic expressions are obtained for linearized particle concentration perturbations δN and plasma potential φ. Integrals representing the solution are evaluated numerically for distances exceeding $r \sim DV_0/v_i$, i.e., in the "intermediate zone" and up to the distant zone ($r \gg DV_0/v_i$). In this region the integrals agree with the well-known asymptotic expressions for δN and φ. (auth)

1756 QUANTUM KINETIC EQUATIONS FOR AN IMPERFECT GAS AND A NONIDEAL PLASMA. Klimontovich, Yu. L.; Ebeling, V. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 3, 905-17(Sep 1972). (In Russian).

Quantum kinetic equations for an imperfect Boltzmann gas and a nonideal plasma are deduced without assuming smallness of interaction between the particles. The collision integrals take into account retarding effects of the distribution functions and the effect of an external electric field. The kinetic equations for a nonideal plasma differ from the Boltzmann quantum equation in that mean dynamic polarization of the plasma is taken into account. As a result, the plasma collision integrals converge at large and small distances. The deduction of the quantum kinetic equations for an imperfect gas and plasma is similar to that previously employed for classical systems. Hence the main attention in the paper is directed to a study of principal features of the quantum theory. It is shown that allowance for strong interactions at short distances is particularly important in calculating nondissipative characteristics of a nonideal plasma, since in this case the contributions of bound states, whose lifetimes are much smaller than the mean free path time, are taken into account. The internal energy for nonequilibrium states is calculated. An expression for the state of local equilibrium is obtained which is valid in any arbitrary approximation in perturbation theory. It is shown that the expression takes into account the contribution of bound states. The effective field is calculated by taking into account quantum corrections for an arbitrary ratio of the de Broglie radius to the Debye radius. (auth)

1757 THERMODYNAMIC FUNCTIONS OF NONTHERMAL RADIATING SYSTEMS. Suckewer, S. (Inst. of Nuclear Research, Warsaw). Lett. Nuovo Cim.; 4: No. 9, 333-6(1 Jul 1972).

A pseudothermodynamic model is used to describe a steady-state hot gas or plasma enclosed in a unit volume. External energy is supplied to the system to compensate for the radiation energy losses. The system is treated as a mixture of ideal gases. The influence of electron–atom collisions on the excitation, de-excitation, ionization, and recombination, and also the effect of atom–atom and atom–ion collisions are taken into account. (M.O.W.)

1758 ROLE OF NONLINEAR EFFECTS IN THE PROBLEM OF ANOMALOUS RESISTANCE OF A PLASMA. Kingsep, A. S. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 498-501(Aug 1972). (In Russian).

The role of nonlinear effects in the problem of anomalous resistance of a plasma in asymptotic conditions is investigated. It is shown that from the self-similar solution obtained in the quasi-linear approximation, an instability of the explosive type formally derives that possesses characteristic development times significantly smaller than the fundamental time dimension in the self-similar problem. Allowance for nonlinear effects leads to the establishment of rigid limits of applicability of results obtained in the quasi-linear approximation. (auth)

1759 COLLISION INTEGRAL FOR A LOW DENSITY PLASMA (QUANTUM THEORY). Alyamovskii, V. N. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 918-29(Sep 1972). (In Russian).

An approximate method is proposed for solving the Bogolyubov set of pinning quantum equations in the case of a long-range interaction potential between the particles which is strong at short distances. The pair correlation functions for a low-density spatially homogeneous gas are found as functionals of single-particle distribution functions. On this basis, kinetic equations for a low-density electron plasma are obtained that do not contain any divergences and are applicable throughout the whole nonrelativistic range of particle velocities. For $e^2/\hbar v_{av} \to \infty$ they go over to the classical mechanics result obtained earlier by the author and for $e^2/\hbar v_{av} \to 0$ they are identical to the asymptotic of the Balescu–Silin equations for extremely low densities. (auth)

1760 QUANTUM STATISTICS OF A FULLY IONIZED GAS IN A UNIFORM MAGNETIC FIELD. Rosa, Sylvio Goulart Jr.

Laramie, Wyo.; Univ. of Wyoming (1972). 137p. University Microfilms Order No. 72-26,517.

Thesis.

The quantum statistics of a fully ionized multicomponent gas of interacting particles in a uniform magnetic field is developed by generalizing the diagrammatic theory of Lee–Yang–Mohling–Grandy. The magnetic field is conveniently included in the formalism by using the Landau wave functions to evaluate the matrix elements of the interactions (cluster vertices) and the Landau energy levels $E_{\alpha s}$ to express the statistical factor $\epsilon e^{\beta(g-E_{\alpha s})}$. The advantage of this approach is that the perturbation expansion of the grand potential can be represented by the same set of diagrams as in the free field case (B = 0); however, the analytical expressions associated with the graphs are different from those for B = 0. The difference is basically due to the new values of the cluster vertices and statistical factors. (TSS) (Diss. Abstr. Int., B)

1761 YIELD COEFFICIENT OF CYCLOTRON RADIATION FROM A THERMONUCLEAR PLASMA. Trubnikov, B. A. (Inst. of Atomic Energy, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 25-7(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 37-9(5 Jul 1972).

An analysis of three examples of numerical calculations shows that the radiation yield coefficient can be approximated, with 50% accuracy, by a "universal" formula suitable for a plasma layer, cylinder, and torus: $\Phi \cong 60(t^{3/2}/\sqrt{P_a})\sqrt{1-r}\sqrt{1+\chi_T}$. Here $t = T/mc^2$ is the temperature in units of $mc^2 = 511$ keV, $p_a = a\omega^2/c\omega_B$ is the dimensionless "opacity parameter," in which a is the radius of the cylinder, the thickness of the flat layer, or the minor radius of the torus, $\omega_0^2 = 4\pi n_e e^2/m$ is the square of the plasma frequency, $\omega_B \simeq eB/mc$ is the cyclotron frequency of the electron, c is the speed of light, r is the reflection coefficient of the mirrors located at the plasma boundary, and $\chi_T = a/R\sqrt{t}$ is the parameter of the inhomogeneity of the magnetic field in a torus with minor and major radii a and R. The adaption of this formula to other cases is discussed. (M.O.W.)

Production

1762 (UCRL-50022-2) LLL LASER PROJECTS REPORT NO. 2. Kachen, G. I.; Shaw, Gary (eds.) (California Univ., Livermore. Lawrence Livermore Lab.). Aug 1972. Contract W-7405-eng-48. 9p. Dep. NTIS.

Two reprints from recent LLL reports are included. These deal with laser–plasma coupling and wavelength dependence of laser–light absorption by solid deuterium. (M.O.W.)

1763 (UCRL-73931) LASER POSSIBILITIES IN PULSED CONTROLLED THERMONUCLEAR FUSION. Shearer, J. W. (California Univ., Livermore. Lawrence Livermore Lab.). 24 Aug 1972. 20p. (CONF-721023-1). Dep. NTIS.

From Conference of the Cryogenic Society of America; Chicago, IL. (3 Oct 1972).

It has been proposed to use a laser to heat a deuterium plasma in a uniform magnetic field similar to "conventional" fusion machine concepts. Large cryogenically cooled coils would be needed to provide fields of a hundred kilogauss or greater. Another suggestion is that small thermonuclear "microexplosions" be created in a thick-walled vacuum chamber by means of a spherical array of laser beams focused on small spherical pellets of solid heavy hydrogen. These pellets must be prepared cryogenically and propelled into the vacuum chamber. This controlled-fusion concept does not require a magnetic field for containment because the pellet plasma is so dense that sufficient nuclear reactions occur before it comes apart. The proposal involves questions of explosion magnitude and repetition rate, efficiencies of laser operation and light absorption, and energy recovery. Much additional research is needed to evaluate the viability of these proposals and to compare them with other controlled-fusion concepts. (auth)

1764 STEADY-STATE HIGH-DENSITY MAGNETIZED ARC COLUMN. Jassby, D. L. (Univ. of California, Los Angeles). J. Appl. Phys.; 43: No. 11, 4542-8(Nov 1972).

A steady-state fully ionized plasma column of density 10^{16} cm^{-3} and temperature 1.6 eV was achieved in a simple magnetically confined argon arc of 9- to 15-cm length and 1.2-cm-diameter current channel. The plasma potential fluctuation level, eV/kT, is 0.1%, or less when the initial gas pressure is above 4 torr, or when the arc current and magnetic field are below critical values. (auth)

1765 EFFECT OF PLASMA MIRROR IN THE BREAKDOWN OF AIR IN A CO_2 LASER CAVITY. Karlov, N. V.; Komissarov, V. M.; Kuz'min, G. P.; Prokhorov, A. M. (Lebedev Physics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 65-7 (20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 95-8(20 Jul 1972).

The experiment was performed with a transverse-excitation CO_2 laser of 5-m length, delivering in the free-running mode radiation pulses of 10-μs duration with energy 10 J. When the laser radiation intensity approaches the breakdown threshold, self-modulation of the radiation occurs in the prebreakdown state. The total duration of the generation increases from 10 to 30 μs, the pulse is transformed into a practically regular series of short pulses. The generation is quenched as a result of self-defocusing occurring in the focal region of the resonator. High-speed photographs and the corresponding variation of the plasma luminosity, obtained with the aid of a photomultiplier, are discussed. (M.O.W.)

1766 PULSED UV-RADIATION SOURCE FOR PRODUCING HIGHLY IONIZED LOW-DENSITY INITIAL PLASMAS. Gattinger, A. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 254: No. 5, 424-36(1972). (In German).

A 100-kV z-pinch, pulse-filled with high-density xenon gas is used as a radiation source for photoionizing hydrogen or rare gases at filling pressures of 1 to 10 mtorr. This produces a homogeneous, magnetic-field-free, highly ionized (degree of ionization ≈10% in H_2 and ≈20% in Ar) plasma suitable for example, for collisionless shock-wave experiments. Experimental and theoretical investigations have yielded information on the conversion of the stored electrical energy into radiation energy. As a result of fast magnetic compression and ohmic heating (the relatively low temperature of max. 6 eV due to multiple ionization of the xenon atoms being favorable) the xenon pinch absorbs 30% of the stored electrical energy. Investigation of the matching of the external circuit to the z-pinch by means of the snowplow model shows that the energy-transmission efficiency could be increased about 50% if the current half-cycle is made equal to the compression time. The suitability of the xenon pinch as a radiation source is due, on the one hand, to the almost complete conversion of the absorbed energy into radiation and, in particular, to the spectral distribution of the radiation, which is favorable for the ionization of hydrogen. It is found that the radiation is mainly emitted in lines with maximum intensity at the same wavelength $\lambda \approx 700$ Å as the maximum of the photoionization cross section owing to the low temperature of the xenon plasma. (auth)

Stability

Refer also to abstracts 1758 and 1797.

1767 (LRP-52/72) TRANSVERSE DYNAMIC STABILIZATION OF A SCREW PINCH. Lister, G. G.; Troyon, F. S.; Weibel, E. S. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jul 1972. 12p. Dep. NTIS (U. S. Sales Only).

The influence of a small, steady axial current on the stability of a straight plasma column confined by a static axial magnetic field and a small oscillating transverse magnetic field is discussed. Stability conditions are derived and compared with those previously obtained in the absence of the steady current. The possibility of obtaining a toroidal equilibrium by using a steady current which is above the Kruskal–Shavranov limit and dynamically stabilizing the resultant instability is also discussed. (auth)

1768 (LRP-53/72) STABILITY OF A SYSTEM IN WHICH ONE PARAMETER OSCILLATES SINUSOIDALLY WITH SMALL AMPLITUDE. Lister, G. G.; Troyon, F. S. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jul 1972. 24p. Dep. NTIS (U. S. Sales Only).

The study of the dynamic stabilization of certain plasma confinement and fluid systems leads to equations of the form $(X + 2A\cos(\omega t - \phi))\, y(t) + \int_0^t R(t-t')\,\ddot{y}(t')\,dt' = 0$, where X and A are constants, ϕ an arbitrary constant, and R(t) a singular response function. This equation is solved for all values of A, and the general stability properties of the system are discussed. General formulas are given that relate the perturbed spectrum of the system to the unperturbed system. For the case where the static system has well-separated eigenfrequencies, a perturbation expansion is derived. (auth)

1769 (MATT-921) EFFECT OF INJECTION FUEL ENERGY ON FUSION REACTOR STABILITY. Fujisawa, Takeo (Princeton Univ., N. J. Plasma Physics Lab.). Sep 1972. Contract AT(11-1)-3073. 25p. Dep. NTIS.

The effect of injection fuel energy on the plasma-dynamics stability of a stationary fusion reactor is investigated, using a mathematical model based on the energy density and particle density of four plasma constituents. For this purpose, numerical

calculations of eigenvalues are made after linearization of a set of plasma equations. The result suggests that a neutral-beam injection gun of moderate energy is favorable to realizing a stable plasma rather than a pellet-injection method of very low energy. Further calculation is made for studying the inner mechanism of plasma self-stabilization. (auth)

1770 PARAMETRIC INSTABILITIES AND ANOMALOUS HEATING OF PLASMAS NEAR THE LOWER HYBRID FREQUENCY. Kindel, J. M. (Los Alamos Scientific Lab., N. Mex.); Okuda, H.; Dawson, J. M. Phys. Rev. Lett.; 29: No. 15, 995-7(9 Oct 1972).

It is shown both by theory and by computer experiments that a plasma subjected to a long-wavelength electric field oscillating near the lower hybrid frequency causes parametric instabilities that lead to an anomalous heating of both ions and electrons. Because the instability threshold is much lower than that for the corresponding electron plasma-wave problem, the saturation of the electric field can be much higher. (auth)

1771 STABILITY OF FINITE-SIZED RADIATING PLASMAS. Manley, O. P.; Treve, Y. M. (Visidyne Inc., Woburn, Mass.). J. Math. Phys. (N. Y.); 13: No. 8, 1176-85(Aug 1972).

It is shown that the onset of instabilities in a finite-sized, optically thin, radiating plasma coincides with the loss of uniqueness of solutions to the governing nonlinear differential equations. Furthermore, conditions on the luminosity function are derived for the existence of metastable states of such plasmas with dimensions smaller than the critical maximum size derived from conventional normal mode stability analysis. The results are applied to a simple configuration modeling free–free emission from a confined radiating, high-temperature plasma. (auth)

1772 DRIFT INSTABILITIES IN A COLLISIONLESS INHOMOGENEOUS PLASMA: NUMERICAL STUDY. Brossier, P.; Deschamps, P.; Gravier, R.; Renaud, C. (CEN, Fontenay-aux-Roses, France). Nucl. Fusion; 12: No. 4, 453-60(Jul 1972). (In French).

The linear growth rate of drift instabilities at low frequency is calculated numerically. The calculation also gives the characteristics of the unstable waves: wavelength, frequency, phases between the fluctuations of potential, density, and temperature. The system of curves with constant growth rate allows the study of the effects of the Debye length, the mass ratio, the anisotropy of the temperatures, and the temperature gradients on the stability. (tr-auth)

1773 NONLINEAR EVOLUTION OF FLUTE-LIKE PLASMA MICROINSTABILITIES. Crume, Enyeart Charles Jr. Knoxville Tenn.; Univ. of Tennessee (1972). 122p. University Microfilms Order No. 72-27,456.

Thesis.

The evolution of linearly unstable high frequency ($\omega \approx n\Omega$), like ($k_{||} = 0$), electrostatic modes that can occur in a multicomponent, magnetic-mirror-confined collisionless plasma has been studied by a computer simulation. An infinite, periodic, sheet charge model was used in which particle motion is followed in one spatial coordinate and two velocity coordinates normal to a constant magnetic field. Approximately one quarter of the particles in the initial velocity distributions formed a warm, Maxwellian background component; the remainder belonged to a hot, linearly stable, loss-cone component. These velocity distributions were constructed in such a way as to provide initial states relatively free of randomly fluctuating electric fields. The early evolution of single wave (either traveling or standing), resonant instabilities agrees well with linear theory. A rapid, coherent heating of the warm component occurs and spatial harmonics of the unstable wave appear. The electrostatic field of the wave then saturates at an energy level as much as two orders of magnitude lower than those reported in previous simulation studies of the same and related instabilities or predicted from earlier nonlinear analysis. The field amplitude decreases rapidly to zero after saturation and then grows again nonlinearly. The temperature of the warm component reaches a maximum when the field amplitude vanishes. During and subsequent to this nonlinear growth period, details of the evolution of the field amplitude vary from case to case. The saturation levels and early post-saturation behavior are in agreement with a recently reported nonlinear analysis which was motivated by the simulation results. (Diss. Abstr. Int., B)

1774 FLUTE-LIKE INSTABILITIES IN A STRONGLY CURVED MAGNETIC FIELD. Martin, J. G.; Emmert, G.; El-Derini, Z. (Univ. of Wisconsin, Madison). J. Appl. Phys.; 43: No. 11, 4565-9(Nov 1972).

For three different distribution functions, the analysis of low-frequency flute-like instabilities of a low-β collisionless plasma immersed in the magnetic field of a line current indicates that the qualitative characteristics of the instabilities are independent of the distribution function. The analysis is valid for arbitrary curvature in the absence of magnetic shear and mirror effects. Numerical results for the growth rate and phase velocity for one of the distribution functions illustrate the behavior of the various instabilities, and comparison with Taylor's minimum-B theorem shows which particles in velocity space provide the energy to drive the instabilities. (auth)

1775 NECESSARY AND SUFFICIENT CONDITION FOR HYDROMAGNETIC STABILITY OF THE BENNETT PINCH. Kaneko, Shobu; Tsunematsu, Toshihide (Tokyo Univ.). J. Phys. Soc. Jap.; 33: No. 5, 1442-7(Nov 1972).

Newcomb's method for obtaining the necessary and sufficient condition for hydromagnetic stability is applied to the linear Bennett pinch of length $2\pi R$. For the kink mode, the obtained necessary and sufficient condition for stability is $\beta_z \leq F(R/r_0)(r_0/R)^2$, where β_z and r_0 are the toroidal β and the mean radius of the pinch, respectively. The function $F(R/r_0)$ is positive definite and increases monotonically from $F(0) = 0$ to $F(\infty) = 1.0$. It varies slowly for large R/r_0, i.e., it is larger than 0.9 if $R/r_0 > 3.0$. For the sausage mode, the necessary and sufficient condition for stability is $\beta_z \leq 3.80$. The Bennett pinch is hydromagnetically stable if both conditions are fulfilled. Tokamak T-3 fulfills these necessary and sufficient conditions. (auth)

Thermonuclear Processes

Refer also to abstract 2015.

1776 (CLM-R-115) USE OF LIQUID LITHIUM AS COOLANT IN A TOROIDAL FUSION REACTOR. PART I. CALCULATION OF PUMPING POWER. Hunt, J. C. R.; Hancox, R. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971. 25p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

An attractively simple concept for the nuclear blanket of a fusion reactor fueled with a deuterium–tritium mixture would be the use of liquid lithium as both a tritium-breeding and heat-transfer medium. The main disadvantage of this idea is the pumping power necessary to circulate the lithium in the presence of the high magnetic field required for plasma containment. The magnetohydrodynamic power loss is calculated for the flow regimes relevant to a toroidal fusion reactor. The calculation is exact for uniform magnetic field and flow conditions, and is compared with published experimental work. A preliminary estimate is made of the pumping power required in a reactor. (auth)

1777 (CLM-R-120) SHIELDING OF SUPERCONDUCTING MAGNETS IN A FUSION REACTOR. McCracken, G. M.; Blow, S. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Aug 1972. 10p. Dep. NTIS (U. S. Sales Only). UK 50p.

The effect of radiation damage on the current density a superconducting composite can carry is discussed, considering damage in the superconductor itself and in the normal conductor used for stabilization and protection. The maximum fast neutron fluence that can be sustained for a 10% reduction in current density was estimated to be $\sim 10^{18}$ n·cm^{-2} for the superconductor and $\sim 10^{17}$ n·cm^{-2} for the normal conductor. Using results from Monte Carlo computations of the neutron flux reduction per unit thickness of shield, the shield thickness required to meet the above criteria is calculated as a function of reactor wall loading, and these results are compared with those calculated on purely thermal criteria. (auth)

1778 (CONF-720948-7) INTENSE ION BEAM PRODUCTION BELOW 40 keV. Stirling, W. L.; Davis, R. C.; Jernigan, T. C.; Morgan, O. B.; Orzechowski, T. J.; Schilling, G.; Stewart, L. D. (Oak Ridge National Lab., Tenn.). [nd]. 10p. Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

An objective of the ORNL CTR ion-source development program is to create a hydrogen ion source with an extracted current of 10 A at beam energies above 20 keV. This source and multiples thereof are used to heat and/or create hot ion plasmas for fusion research. A modified version of the four-electrode duoplasmatron has been developed that is called a duoPIGatron. A 4-A current has been extracted for 0.1 sec at voltages between 20 kV and 40 kV from multiaperture extraction grids. The grids are connected in accel–decel fashion and are 55% transparent. Optimum curvature of the first grid allows 68% of the current to be incident on a 9-cm-dia target 100 cm from the source. A 5-A current has been obtained from a scaled-up version of the source. Computer-predicted current yields are in general agreement with the experimentally measured values. Studies of the ion source plasma show an m = 1 helical instability to be present that is responsible

for illuminating the 5-cm-diameter extraction surface. Instantaneous density variations from ±10% to ±50% are observed to be driven by the instability at 300 to 400 kHz. A stabilizer has been developed that reduces the oscillation amplitude by an order of magnitude. Initial studies at extraction voltages up to 10 kV show that use of the stabilizer yields a less-divergent beam and higher current output through a single aperture either on axis or 1.75 cm from the source axis. (auth)

1779 (CONF-721110–1) ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE BLASCON ENERGY CONVERSION SYSTEM FOR LASER-FUSION REACTORS. Fraas, A. P.; Dresner, L.; Holcomb, R. S.; Lackey, M. E. (Oak Ridge National Lab., Tenn. [nd]. 16p. Dep. NTIS.

From American Nuclear Society winter annual meeting; New York, NY. (12 Nov 1972).

A brief review of the BLASCON concept is given. Research on a model to determine the blast wave effects on the structure is described. The effects of neutrons and x radiation on wall loading are considered also. (M.O.W.)

1780 (CONF-721111–1) OPTIMIZATION OF THE DESIGN FOR COOLING THE BREEDING BLANKET OF THE PRINCETON REFERENCE DESIGN MODEL OF A FUSION POWER REACTOR. Davison, P. W. (Princeton Univ., N. J. Plasma Physics Lab. Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). 1972. Contract AT(11-1)-3073. 5p. Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX. (20 Nov 1972).

A study was made for optimizing the design of the cooling system for the breeding blanket of the Princeton Reference Design Model of a Fusion Power Reactor. The constraints observed were: compatibility with the overall design of the reactor; use of "conventional" structural materials; use of eutectic flibe for breeding; and use of helium for heat transfer. The parameters varied were: cooling-tube diameter and/or length; cooling-tube wall thickness; coolant pressure; and heat load per tube in high-heat-flux regions. The results of the study indicate that the most satisfactory parameter for optimization was the cooling-tube diameter and the optimum value was found to be between 2- and 3-cm outer diameter. The other parameters gave optima at limiting constraints. (auth)

1781 (EUR-CEA-FC–651) ALL-METAL TOROIDAL ENCLOSURE FOR HEATING A PLASMA WITH OSCILLATING ELECTROMAGNETIC FIELDS. Consoli, T.; Jeffroy, G.; Nagao, S.; Zymanski, S. (Commissariat a l'Energie Atomique (France). Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1972. 46p. (In French). Dep. NTIS (U. S. Sales Only).

Metallic structures formed from an assembly of metallic bars or tubes, which can be interposed between the hf heating coils, the body, and the plasma, are proposed. The assemblies act as all-metal liners for the plasma, however their discontinuous structure renders them transparent to the hf field. The various losses that occur are discussed. Practical solutions are presented that have applications in a tokamak or a stellarator, certain elements of the structures already being at the experimental stage. The limiting case, in which the coil is inside the stainless enclosure and the face facing the hf coil is covered with a special protective coating, is considered. (France)

1782 (LA-DC–72-1090) HIGH-ENERGY GAS LASERS FOR POSSIBLE FUSION APPLICATIONS. Boyer, Keith (Los Alamos Scientific Lab., N. Mex.). 1972. 25p. (CONF-720929–2). Dep. NTIS.

From Japan–U. S. seminar on laser interaction with matter; Kyoto, Japan (25 Sep 1972).

The development program aimed at producing a high-energy CO_2 laser operating at 10.6 μm is described. The high-pressure operation required the development of a new technique for controlling the electric discharge used for pumping. Pumping and amplifier design studies are outlined. (M.O.W.)

1783 (ORNL-TM–3756) ANALYSIS OF A RECIRCULATING LITHIUM BLANKET DESIGNED TO GIVE A LOW MAGNETOHYDRODYNAMIC PUMPING POWER REQUIREMENT. Fraas, A. P. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 40p. Dep. NTIS.

A new approach to the problem of circulating liquid metal in the blanket of a fusion reactor was evolved in an effort to keep the fluid pressure drop and pumping power to low levels. Analysis of a specific embodiment of the proposed design indicates that it more than meets the desired objectives. The effects of wall heat loading, reactor size, the proportions of the system, and related factors are discussed. The latter includes flow stability, thermal stresses, and the effects of a widely varying poloidal field in a tokamak. Consideration of these factors indicates that in employing the proposed system the designer has wide latitude in his choice of wall heat loading, reactor size, and field strength, hence the writer concludes that the MHD pressure drop and pumping power ought not represent serious design limitations over the range likely to be of interest in the design of lithium blankets for toroidal or mirror reactors. A one-sixth scale model of an element of the system is described, and it is proposed that this be built and tested to provide a relatively simple and inexpensive rough check on the analysis. (auth)

1784 (ORNL-TM–4022) SUMMARY OF TRITIUM HANDLING PROBLEMS IN FUSION REACTORS. Watson, J. S. (Oak Ridge National Lab., Tenn.). Nov 1972. 23p. Dep. NTIS.

The problems in handling tritium in thermonuclear reactors are reviewed and assessed. The most difficult problems appear to be associated with recovery of tritium formed or bred in the blanket of D–T reactors. The need to control the rate of tritium leakage to the steam system and thus to the environment imposes severe limitations on allowable tritium concentrations and pressures in both the blanket and secondary coolant fluids. Possible tritium recovery processes are reviewed and evaluated using the fragmentary data currently available. The most promising processes for recovery from lithium or molten fluoride blanket fluids or from potassium or helium coolants are discussed. (auth)

1785 (UCRL–74082) PRODUCTION OF INTENSE NEGATIVE ION BEAMS. Osher, J. E.; Gordon, F. J.; Hamilton, G. W. (California Univ., Livermore. Lawrence Livermore Lab.). 18 Aug 1972. 10p. (CONF-720948–4). Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

Negative ion beams have long been of interest for various nuclear physics and accelerator uses. Recently, it has become evident that very intense D^- beams would be desirable for long-range controlled fusion applications — either for efficient high-energy neutral beam production or for direct injection into a fusion reactor for fueling or heating purposes. Preliminary experiments are reported on intense beam formation both by direct extraction of negative ions from a calutron type of ion source and by use of multiple electron pickup by a low-energy D^+ beam from a multiple aperture source passing through an alkali metal charge exchange cell such as cesium. (auth)

1786 MAGNETIC CONTAINMENT FUSION: WHAT ARE THE PROSPECTS? Metz, William D. Science; 178: No. 4058, 291-3(20 Oct 1972).

The problems of building a practical reactor and the environmental effects that might be expected if fusion were to become a major energy source are discussed. (M.O.W.)

1787 SOME TECHNOLOGICAL PROBLEMS IN FUSION REACTOR DESIGN. Forsen, Harold K. (Univ. of Wisconsin, Madison). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 857-62(Aug 1972).

A review of possible fusion reaction cycles with the associated neutron production rates and energies is presented. Some of the problems in having to thermalize and capture these neutrons for D–T cycles are outlined in terms of likely neutron wall currents and resulting neutron fluxes. Due to the energy of these neutrons other problems arise because of elastic and inelastic collisions. Such collision rates and displacements per atom for a "standard blanket" are presented. Problems in thermal and transient magnetic stress loading are also outlined. (auth)

1788 REVIEW AND STATUS OF THE CHALLENGE OF FUSION. Forsen, H. K. (Univ. of Wisconsin, Madison). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 22-3(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1789 SCALING LAWS OF TOKAMAK-TYPE DEVICES. Nagao, Shigeo; Watanabe, Hiroshige; Funato, Yasuyuki; Fujino, Yutaka (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 557-60(Sep 1972).

It has been recently reported by Furth, Rosenbluth, Rutherford & Stodiek (Phys. Fluids, 13: 3020(1970)) that the main characteristics of the temperature and density profiles of current-carrying plasma columns such as embodied in Tokamak-type devices can be described for practical purposes by equations of thermal equilibrium. A new constant η is tentatively applied by the present authors to estimate the fraction of Joule heat that is transferred from electrons to ions, considering the remainder $(1-\eta)$ to be lost directly through the electrons themselves. The other quantities have their conventional meanings. The plateau model of thermal conductivity was used for analytical convenience and toroidal effects were embodied in the major radius R. It should be of interest to derive from these equilibrium equations the ion temperature T_i, the plasma density n, and the energy confinement

time τ_E, which can be used as scaling laws for devices of this type. (M.O.W.)

1790 SLUG-MODE OPERATED COAXIAL PLASMA GUN AS A SOURCE OF LOW-ENERGY NEUTRAL PARTICLES. Schmidt, Howard Joseph. Houston, Tex.; Univ. of Houston (1972). 190p. University Microfilms Order No. 72-27,524.

Thesis.

The ion and neutral particles fluxes derived from a slug-mode operated coaxial plasma gun were studied. Using a time-of-flight technique, the significant ion parameters were determined: ion temperature, plasma flow velocity, ion flux normalization constant, and time of release of the plasma from the gun relative to the discharge initiation. Ion fluxes from discharges in hydrogen, helium, neon, and argon were studied. (TSS) (Diss. Abstr. Int., B)

1791 NUMERICAL SIMULATION MODELS OF THE PLASMA BETATRON. Whitfield, Douglas Wilbert Alfred. Saskatoon, Saskatchewan; Univ. of Saskatchewan (1971). 183p. University Microfilms Order No. 72-23,478.

Thesis.

The technique of numerical plasma simulation on a digital computer was used to model some results from the University of Saskatchewan plasma betatron. Except for one largely inconclusive two-dimensional simulation, all of the work was one-dimensional and electrostatic. By making detailed comparisons with experimental measurements, it is possible to indicate some points where the effects included in the model are adequate to explain the real plasma behavior and some where they are not. It is shown that in a one-dimensional plasma with an initial sinusoidal density perturbation (representing the effect of a bumpy magnetic field parallel to the plasma current in the experiment), the application of a constant external electric field [type (i) simulation] can cause the electrons to split into two groups, one freely accelerating and the other trapped near zero velocity in a potential well resulting from the inhomogeneous ion density. The ensuing electron–electron instability can cause reduced acceleration and heating of the electrons, even when the ions are infinitely massive. When an external field that rises from zero is applied, [type (ii) simulation], the number of electrons in the trapped group is so small that electron–electron interaction has no significant effect. Instead, a new instability is seen, which again affects electron macroscopic quantities even when the ion mass is infinite, and which has large growth rates when the drifting electrons "see" harmonics of the ion density perturbation at their plasma frequency. In simulations of type (iii), applied electric fields rising from zero and corresponding to ones measured in the plasma betatron were applied to an electron–ion plasma. When there was no initial density perturbation, current-driven electron–ion instabilities caused electron and ion heating and reduced acceleration after about one ion plasma period, which is earlier than would be expected in a real plasma because of the unavoidable exaggeration of the initial fluctuation energy inherent in the simulation. The presence of an initial density perturbation in one sinusoidal mode led to the trapping of a small number of electrons and a resulting weak electron–electron instability. A multiple-mode perturbation greatly shortened the time required for development of macroscopic effects. (TSS) (Diss. Abstr. Int., B)

1792 ENERGY DEPOSITION IN PARALLEL-PLATE PLASMA ACCELERATORS. Di Capua, Marco Sabado. Princeton, N. J.; Princeton Univ. (1972). 180p. University Microfilms Order No. 72-24,710.

Thesis.

To appraise the ratio of energy deposition into kinetic and thermal modes in plasma accelerators, a parallel-plate plasma accelerator was operated in the quasi-steady mode with current pulses in the range 10 to 100 kA, durations of the order of one ms, and argon mass flows up to 100 g/s. From photographic observations, spectroscopic measurements of velocity and electron density and pressure measurements with a fast-rise piezoelectric transducer it is found that, for currents between 50 and 90 kA, the accelerated argon plasma is supersonic with ion velocities of 5 to 6 km/s, electron densities of 4 to 7×10^{16} cm^{-3}, and static pressures of 0.3 to 0.5 atm. A momentum and energy balance obtained through a one-dimensional analysis shows that a large fraction (85%) of the input power (10 to 20 MW) delivered to the plasma appears in the exhaust flow. However, only 20% of the power in the exhaust appears as directed kinetic energy of the flow. The remainder appears as enthalpy of the flow which includes ionization. The energy deposition ratio, calculated as the ratio of the velocity squared divided by twice the enthalpy, shows reasonable agreement with the ratio of induced emf calculated on the basis of the prevailing velocities and magnetic fields and resistive voltage. Both these ratios indicate that the discharge imparts more energy to the flow by resistive heating than by direct-body-force acceleration. A magnetic boundary-layer model, which considers the convection of the magnetic field by the flow and the diffusion of the magnetic field in the conducting fluid, is used to explain some of the features of the discharge region. (Diss. Abstr. Int., B)

1793 NEW METHOD FOR CONTROLLED NUCLEAR FUSION. Plantikow, U. (Kernforschungsanlage, Juelich, Ger.). Naturwiss. Rundsch.; 25: No. 7, 265-7(1972). (In German).

A short survey of presently known thermonuclear configurations is given, followed by a description of the basic concept of the TESI device (toroidal experiment with helical core conductor) at Juelich. This device combines a normal theta pinch with a core-conductor-supported anti-theta pinch and has an elliptical plasma cross section with triangular corrections. (GF)

Wave Phenomena

1794 (COO–3237-11) PARAMETRIC INSTABILITY AND ANOMALOUS BACKSCATTERING OF ELECTROMAGNETIC WAVES IN UNDERDENSE PLASMAS. Liu, C. S. (Institute for Advanced Study, Princeton, N. J.). 1972. Contracts AT(11-1)-3237; AT(04-3)-34. 9p. Dep. NTIS.

The conditions for stimulated backscattering of electromagnetic waves by plasma waves in an underdense plasma ($\omega_0 \gg \omega_p$), where the Debye length is smaller than the incident laser wavelength, are derived. In an inhomogeneous plasma with density scale length L, significant amplification is attained if $c\epsilon_0^2/4\pi > nmc^4\omega_0/2\omega_p^2 L$. Application to pellet irradiation by laser is considered. (auth)

1795 (RISO-M–1513) EXPERIMENTAL INVESTIGATIONS OF CONDITIONS IN AN APPROXIMATE ION-ACOUSTIC PERTURBATION PROPAGATION IN THE COLLISION-FREE Q-MACHINE PLASMA. Christoffersen, G. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 42p. (In Danish). Dep. NTIS (U. S. Sales Only).

The principal experimental work done with the Q machine at Risø from 1970 to 1972 is summarized. The Q machine is described. The plasma is characterized by means of velocity distributions for ions and electrons. The interactions between plasma and the grating and methods of heating electrons are considered. Characteristics of the plasma equilibrium state are then given. Investigations on pulse and wave propagation through plasma are described. Pulses and waves were excited by means of the grating, and propagation conditions were studied by measurement of the perturbation in ion velocity distributions. (tr-auth)

1796 (UCRL–73959) PENETRATION OF ELECTROMAGNETIC WAVES INTO PLASMA. De Groot, J. (California Univ., Livermore. Lawrence Livermore Lab.). 1972. 14p. (CONF-720656–1). Dep. NTIS.

From Gordon research conference; Tilton, NH. (19 Jun 1972).

Plane electromagnetic waves in plasma are reviewed. The penetration, reflection, and absorption are briefly described. Linear and nonlinear theories of instabilities are also discussed. (M.O.W.)

1797 NONLINEAR OSCILLATIONS AND CAPTURING OF PARTICLES BY WAVES IN PLASMA. Akhiezer, A. I.; Polovin, R. V. (Kharkov State Univ.). Teor. Mat. Fiz.; 12: No. 3, 407-19(Sep 1972). (In Russian).

Effect of particle capturing by plasma waves on the dispersive properties of the waves is investigated. Periodic waves of finite amplitude are studied specifically for the case of arbitrary number of cold streams of electrons and ions penetrating each other. Dispersion equations relating the frequency of the oscillations and the wavelength to the wave amplitude are obtained, and it is shown that capturing of the particles can produce a stabilizing effect on the plasma oscillations. In the case of a single sort of particle captured it is necessary and sufficient for this that the density of the particles captured would decrease with increase of their potential energy. Nonlinear periodic waves of the charge density in the dielectric medium penetrated by the stream of charged particles are investigated, and it is shown that capturing of these particles by the wave can stabilize the wave growth. (auth)

1798 AMPLITUDE DISPERSION AND STABILITY OF NONLINEAR WEAKLY DISSIPATIVE WAVES. Cap, Ferdinand F. (Goddard Space Flight Center, Greenbelt, Md.). J. Math. Phys. (N. Y.); 13: No. 8, 1126-30(Aug 1972).

A method to solve nonlinear dissipative wave equations using ideas of Luke, Krylov, and Bogolyubov is presented. The method is compared to Whitham's theory. Dispersion relations for nonlinear dissipative waves, including amplitude dispersion, are discussed. Furthermore, stability problems of such waves are investigated. (auth)

1799 MAGNETIC PULSATION SPECTRA IN A NONISOTHERMAL PLASMA. Livshits, M. A.; Tsytovich, V. N.

(Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 540-8(Aug 1972). (In Russian).

Nonlinear interactions between magnetic pulsations and ion-sound pulsations in a nonisothermal magnetoactive plasma are investigated. Interactions between collisionless Alfven or magnetohydrodynamic waves and magnetized ion-sound waves in the low frequency region ($\omega < \omega_{Hi}$) are considered. Interactions between helicons (whistlers) and unmagnetized ion sound in the $\omega_{Hi} < \omega > \omega_{He}$ frequency range are considered. The nonlinear interaction equations obtained are used for estimating the characteristic interaction times and for estimating the stationary turbulence spectra. (auth)

1800 SECOND HARMONIC GENERATION USING NONLINEAR INTERACTION BETWEEN A MODULATED ELECTRON BEAM AND A COLLISIONLESS PLASMA. Basu, B. N. (Regional Inst. of Tech., Jamshedpur, India). Indian J. Pure Appl. Phys.; 10: No. 1, 64-5(Jan 1972).

An approximate theory, neglecting thermal distribution and collisions of the plasma electrons, is developed for second harmonic generation, using nonlinear interaction between a modulated electron beam and a collisionless plasma. At a given distance from the input end, second harmonic current density shows a significant rise for signal at the maximum amplifiable frequency of the system as well as at its half value. For signal frequencies above the maximum amplifiable frequency, the second harmonic current density is found not to grow with distance. (auth)

1801 OSCILLATIONS OF A NONDEGENERATE PLASMA IN QUANTIZED MAGNETIC FIELDS. Korneev, V. V.; Starostin, A. N. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 63: No. 3, 930-9(Sep 1972). (In Russian).

The magnetohydrodynamics equations of a plasma in quantized fields are considered. The stress tensor is calculated and the possibility of a hydrodynamic description of the plasma oscillations is discussed. Oscillations of a nondegenerate plasma are considered by means of the dielectric permeability tensor calculated by the Green function technique. (auth)

1802 INTERACTION OF ELECTROMAGNETIC WAVES WITH PLASMA. Pan, Jaming. Chicago; Illinois Inst. of Tech. (1971). 136p. University Microfilms Order No. 72-22,848.

Thesis.

The macroscopic interaction between electromagnetic fields and a lossy, anisotropic, compressible plasma was investigated. The governing equations are the linearized Boltzmann–Vlasov equation, the Maxwell equations and the equation of continuity. When all these factors are considered, the governing equations are coupled. By separating the longitudinal and transverse components and by rotating the functional space of the longitudinal component, the governing equations are decoupled. The solutions for transformed functions are obtained for a cylindrical symmetry, and then the inverse transformation is applied. After obtaining the solutions for the electric and magnetic fields and for the electroacoustic waves in a real space, the results are used to calculate the scattering of electromagnetic waves by a conducting cylinder with a lossy, anisotropic, compressible plasma sheath. The boundary conditions for an electric and magnetic field are given as its tangential components continuous across the plasma/free space interface. Different boundary conditions for the electroacoustic waves can be chosen. The velocity function is coupled with the electric field and the pressure function. The vanishing velocity or maximum velocity at the plasma/vacuum interface yields different degrees of coupling between the electromagnetic fields and the electroacoustic waves. As a result, the returned signal is different for each set of boundary conditions. The scattering cross sections of an infinitely long and perfectly conducting cylinder with a lossy, anisotropic, compressible plasma sheath are plotted for each set of boundary conditions. (Diss. Abstr. Int., B)

1803 LINEAR AND NONLINEAR IMPULSE RESPONSES FROM A MAGNETOPLASMA COLUMN. Grody, Norman Charles. New York; New York Univ. (1972). 163p. University Microfilms Order No. 72-21,762.

Thesis.

The linear and nonlinear responses of a magnetoplasma resulting from inhomogeneity in the background plasma density are studied. Experiments are performed to measure the plasma response to an impulse electric field and the results are compared to a theory. A 120-picosecond baseband pulse having a maximum peak amplitude of 1860 volts is used to impulsively drive the plasma into the nonlinear regime. The experiments are unique in that due to the extremely short time scale of observation, ionization and electron heating, which alters the plasma background, are absent. Also, the predominant electron relaxation mechanism is not determined by the relatively long-time electron–neutral collisions, but is due to plasma inhomogeneity. Consequently, the observed phenomena arise from the collisionless effects produced by the inhomogeneity in the plasma density. The impulse responses obtained from the impulsive excitation are recorded for the different plasma densities, static magnetic fields, and neutral pressures. Also, the frequency spectra of the waveforms are determined by digital Fourier analysis using a Univac 1108 computer. In general, the impulse response appears as a modulated, damped oscillation and its spectrum consists of two separated resonance peaks. For weak excitation, these results are shown to correlate with the linear theory of a cold, inhomogeneous, cylindrical magnetoplasma. From this theory, the damping mechanism is identified with that of phase mixing due to inhomogeneity in plasma density. With increasing excitation voltage, the nonlinear impulse responses display stronger damping in addition to a small increase in the frequency of oscillation. These results are also observed in the frequency spectra of the waveforms. It is found that this nonlinear behavior is accounted for by the nonlinear theory of a cold, inhomogeneous plasma. The nonlinear mechanism is attributed to electron bunching and multistreaming resulting from inhomogeneity, which acts to remove the phase coherence among the electrons for large excitation. (Diss. Abstr. Int., B)

1804 RESONANT WAVE–WAVE MIXING IN A MAGNETOACTIVE PLASMA. Roberts, Victor David. Cleveland; Case Western Reserve Univ. (1972). 143p. University Microfilms Order No. 72-26,203.

Thesis.

Resonant wave–wave mixing between two longitudinal waves ($\vec{E}||\vec{k}$) in a warm, collisionless, magnetoactive plasma is studied. The specific plasma modes investigated are the cyclotron harmonic wave (CHW), ion acoustic wave (IAW) and pseudowave. The collisionless Boltzmann equation is used to show how the electric field associated with each wave interacts with the plasma particles moving coherently with the other wave to produce a "source" term which has a frequency and wave propagation vector equal to the sum (or difference) of the frequencies and wave propagation vectors of the two input waves. If the frequency and wave propagation vector of the "source" satisfies the plasma dispersion relation, a third propagating wave is established in the plasma. The wave mixing experiment is performed in an rf-generated xenon plasma immersed in a static magnetic field of 110 G. The approximate plasma parameters are: neutral gas pressure, 4×10^{-5} torr; electron density, $5 \times 10^{9}/cm^{3}$; and electron temperature, 2 eV. A CHW at 470 mHz and a IAW at 410 KHz are launched approximately perpendicular to the static magnetic field from opposite sides of the plasma column. They mix to produce another CHW at 469.59 mHz. By the choice of proper transmitting and receiving antenna locations, it is shown that both the frequency and wave propagation vector of the second CHW satisfy the wave mixing equations, thus proving that this wave is generated by resonant wave–wave mixing. The mixing coefficient for this process is found, by a very approximate method, to lie in the range of 1×10^{-4} to 5×10^{-4} meters/volt. Wave–wave mixing between a CHW and a pseudowave is also studied. It is found that, at least for the conditions of this experiment, this process is dominated by sheath mixing instead of resonant wave–wave mixing. (Diss. Abstr. Int., B)

1805 STIMULATED RAMAN SCATTERING OF MICROWAVES IN A LAYER OF COLLISIONLESS PLASMA. Silin, V. A. (Lebedev Physics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 105-8(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 153-7(5 Aug 1972).

An investigation was made of the emission spectrum of a plasma layer having a freely expanding boundary with a characteristic dimension on the order of the radiation wavelength λ_0 at normal incidence of the wave on the layer (with the electric vector E_0 of the wave perpendicular to ∇_n). The measurements were performed under the same conditions as in the experiment on the self-action of microwaves (Batanov and Silin, JETP Lett., 14: 303(1971)). The spectra were investigated with an S4-14 microwave heterodyne analyzer. The spectral analysis was the result of applying the signal of the second intermediate frequency to a delay line with a frequency dispersion. Only the spectra of sufficiently short pulses can be analyzed by this method, since the frequency scale is transformed in the measurements into a time scale. Strobing of the intermediate-frequency amplifier by a pulse of approximate duration 2 μsec was used, and the delay was set in such a way that an analysis was made for the spectrum of the section of the microwave pulse penetrating into the layer in the region from the second to the fourth microsecond from its start. The microwave pulse was turned on at the instant when the electron concentration in the plasma layer reached its maximum value. (J.C.W.)

1806 ANOMALOUS ABSORPTION OF ELECTROMAGNETIC RADIATION AT DOUBLE THE PLASMA FREQUENCY.

Galeev, A. A.; Oraevskii, V. N.; Sagdeev, R. Z. (Inst. of High Temperatures, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 136-9(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 194-7(5 Aug 1972).

The possibility of anomalous absorption of energy of a high-frequency electric field is most frequently attributed to the decay of the pump wave into a plasmon and a phonon near the critical density of the plasma. Calculations are made here to take into account the presence of one more absorption bands at densities one-quarter the critical value necessary in a hot plasma. This absorption is due to the process of the decay of the pump wave into two plasma oscillations. The instability increment can be expressed in terms of the interaction matrix $V_{k_1, k_2 k_3}$ which connects the probability amplitudes of the three waves. (J.C.W.)

1807 DISPERSION RELATION FOR FINITE-AMPLITUDE PLASMA WAVES. Arunasalam, V. (Princeton Univ., N. J.). Contract AT(11-1)3073. J. Appl. Phys.; 43: No. 11, 4938-9 (Nov 1972).

The method of Karplus and Schwinger was used to obtain the nonlinear longitudinal dielectric coefficient for plasma waves. Expressions are then derived for their nonlinear damping and frequency shift. (auth)

1808 KINETIC THEORY OF SCATTERING BY A PLASMA CYLINDER. Weston, V. H. (Purdue Univ., Lafayette, Ind.). J. Math. Phys.; 13: No. 10, 1443-50(Oct 1972).

The kinetic theory of scattering by a circular homogeneous isotropic plasma cyclinder is treated for plane-wave incidence parallel to the axis of the cylinder. The relativistic form of the Vlasov equation is inverted, subject to the specular boundary condition, expressing the electron distribution function in terms of the electric field intensity. After inverting Maxwell's equations and eliminating the distribution function, a set of Fredholm integral equations of the second kind are obtained for the angular Fourier components of the electric field. Since for low temperature the Neumann series converges, the low-temperature solution is easily obtained. The first-order temperature corrections are thus derived for the reflection coefficients associated with the Fourier components. (auth)

1809 SOME REMARKS ON THREE-WAVES INTERACTION. Casati, G.; Lazzaro, E. (CNR, Milan). J. Math. Phys.; 13: No. 10, 1584-5(Oct 1972).

The problem of nonlinear interaction among three waves is analyzed in the case in which one of the waves is initially absent. Clarification is made of some mathematical aspects of the interaction mechanism. (auth)

1810 VLF WAVE PROPAGATION AND ITS INTERACTION WITH THE MAGNETOPLASMA. Shukla, P. K. (Univ. of Umea, Sweden); Singh, R. N. Phys. Scr.; 5: No. 1-2, 81-9(1972).

Propagation of low-frequency electromagnetic waves in the magnetoplasma is discussed. Dispersion relations for cold, collisional plasmas as well as for a cold beam–plasma system are derived. With the help of refractive index surfaces it is shown that the focusing mechanism fails to yield the required strength of vlf waves if collisional and temperature effects in the ambient plasma are taken into account. An alternative mechanism is proposed in terms of wave–particle interactions. It is shown that the vlf signal is amplified by a few orders of magnitude due to resonance interactions. The total amplification of the waves depends on the interaction time. Finally, a possible theory is outlined for the Cherenkov radiation from a beam of charged particles. The detectability of vlf waves is also discussed. (auth) (Sweden)

1811 MOMENTUM OF QUASI-MONOCHROMATIC WAVES IN A PLASMA. Klima, R.; Petrzilka, V. A. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 22: No. 10, 896-905(1972).

Formulas for the momentum of quasi-monochromatic wave packets of transverse and longitudinal waves in a plasma without a magnetic field are derived, including second-order terms in the amplitude of the electromagnetic field. The well-known increase of the momentum of the transverse wave penetrating into the plasma is given by the momentum (transported with the group velocity of the wave) of the averaged motion of the plasma. The laws of energy and momentum conservation lead simply to some results of the theory of the wave decay. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

1812 (CONF-721109–1) SENSITIVITY ANALYSIS OF NEUTRON AND GAMMA TRANSPORT IN AIR. Bartine, D. E.; Mynatt, F. R.; Oblow, E. (Oak Ridge National Lab., Tenn.). [nd]. 6p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

The adjoint flux method was used to study coupled neutron–gamma transport in air. Total tissue dose was calculated at 2000 meters in air for 14-MeV, thermonuclear, and fission sources. Effects of a uniform increase of all cross sections were predicted. (D.L.C.)

1813 (ORNL-TM-3945) PHOTON DOSE RATES FROM THE INTERACTIONS OF 200-GeV PROTONS IN IRON AND IRON–LEAD BEAM STOPS. Gabriel, T. A.; Santoro, R. T. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 41p. Dep. NTIS.

The calculated photon dose rates from the long-lived ($\tau_{\frac{1}{2}} > 1$ min) beta- and gamma-active nuclides produced when 200-GeV protons are incident on a semi-infinite cylindrical iron beam stop having a radius of 40.64 cm (16 in.) are compared with the calculated photon dose rates from long-lived beta- and gamma-active nuclides produced by 200-GeV protons in semi-infinite beam stops having a 30.48-cm (12 in.) radius iron core but surrounded by either 5.08 cm (2 in.) or 10.16 cm (4 in.) of lead. Data are also presented comparing the calculated photon dose rates from the long-lived beta- and gamma-active nuclides produced when 200-GeV protons are incident on semi-infinite cylindrical iron beam stops having radii of 10.16 cm (4 in.), 20.32 cm (8 in.), 30.48 cm (12 in.), and 40.64 cm (16 in.). (auth)

1814 CALCULATION AND MEASUREMENT OF NEUTRON-PRODUCED SINGLE-EVENT SPECTRA. Oldenburg, U.; Booz, J. (EURATOM–CCR, Ispra, Italy). Radiat. Res.; 51: No. 3, 551-68(Sep 1972).

Neutron-produced single-event spectra were measured and calculated for spherical tissue equivalent volumes of cellular and subcellular size (6.5 and 1.0 μm effective diameter, respectively). The experimental spectra were obtained by irradiating a 2-in. Rossi counter with monoenergetic fast neutrons of 0.62, 1.02, 2.01, 3.45, 4.44, and 5.85 MeV. For the calculation, a Monte Carlo program was compiled and executed for the same experimental parameters on an IBM 360/65. Good correlation between experimental and calculated spectra was obtained above 5 keV/μm. There is, however, strong disagreement in the region of smaller event sizes, which is at least partially due to the fact that the gamma contamination of the neutron beam was not considered in the calculation. The theoretical spectra were calculated using energy-dependent W values. Spectra, which were evaluated with a constant W value, show a greater deviation from the measured spectra. (auth)

1815 MONTE CARLO METHOD FOR RADIATION TRANSPORT CALCULATIONS. Razani, Arsalan (Pahlavi Univ., Shiraz, Iran). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 551-4 (Sep 1972).

A probabilistic model for radiation transport calculation is presented, based on the assumption that the motion of particles can be sampled at predetermined points. Due to the fixed sampling points, the directions of motion of particles are discrete, however, the energy of particles can be followed continuously. More specifically, the transport medium is considered to be filled with a cubic lattice, and sampling is made at the corner of the cubes. The Boltzmann transport equation is briefly described, and its connection to the mathematical development of this model is clearly shown. The model and its development is general and has application in many fields associated with radiation transport calculation. (auth)

1816 ANALYTICAL METHODS IN PARTICLE TRANSPORT THEORY. Kriese, John Thomas. Raleigh, N. C.; North Carolina State Univ. (1972). 138p. University Microfilms Order No. 72-24,087.

Thesis.

Analysis related to the method of elementary solutions is reported for problems in the diverse areas of radiative transfer, steady-state two-group neutron-transport theory, and the kinetic theory of gases. (TSS) (Diss. Abstr. Int., B)

1817 MEASUREMENT OF TOTAL ATTENUATION COEFFICIENTS FOR 6- TO 10-MeV PHOTONS. Ahmed, Kamal Uddin. College Station, Tex.; Texas A and M Univ. (1972). 61p. University Microfilms Order No. 72-24,284.

Thesis.

Total attenuation cross sections for five different elements (Al, Fe, Cu, Zr, and Pb) were measured in the energy interval of 6 to 10 MeV photons. This was accomplished by using the discrete energy gamma rays produced by radiative capture of neutrons in various elements (6.02, 7.279, and 9.3 MeV in Fe(n,γ); 7.72 MeV in Al(n,γ); 8.49 and 9.33 MeV in Se(n,γ)). The nuclear resonance scattering method was used in the attenuation of photons for the two energies, 7.27 MeV in Pb and 8.49 MeV in Zr. For other energies, direct narrow beam measurements were made. The cross sections were measured within an average uncertainty of 0.6% and appeared to be in better agreement with the calculated values of Hubbell and Berger than the later calculations of Storm and Israel. (Diss. Abstr. Int., B)

1818 DIFFERENCE BETWEEN AVERAGE AND MOST PROBABLE ENERGY LOSSES FOR THE VAVILOV DISTRIBUTION. Sellers, B.; Hanser, F. A. (Panametrics, Inc., Waltham, Mass.). Nucl. Instrum. Methods; 104: No. 1, 233-5(1972).

Graphical and functional results are given for $\bar{\Delta} - \Delta_p$ in the region where the Airy function can be used in approximating the Vavilov energy-straggling distribution. (auth)

1819 EXPERIMENTAL DETERMINATION OF CHORD LENGTH DISTRIBUTION IN CAVITIES. Holmberg, P.; Sarvaranta, J.; Kiviniitty, K. (Univ. of Oulu, Finland). Health Phys.; 23: No. 4, 578-9(Oct 1972).

An experimental method for the determination of track length distribution in an object is briefly described. The method depended on the systematic measurement of the absorption of γ radiation reaching the body from different directions. The absorption of γ rays (364 keV) was measured and the track length was calculated from a knowledge of the γ-ray linear absorption coefficient of the material used and the γ-ray intensities with and without the absorbing material. The track length distribution is presented for a right circular nylon cylinder (height 4.95 ± 0.02 cm, dia. 9.8 ± 0.1 cm). The advantages of this method for the study of random-shaped cavities are pointed out. (UK)

1820 MEASUREMENT OF INDUCED ACTIVITY TO ESTIMATE PERSONNEL RADIATION EXPOSURES RECEIVED FROM ACCELERATOR BEAMS. Miller, A. J.; Patterson, H. W. (Univ. of California, Berkeley). Health Phys.; 23: No. 5, 671-7(Nov 1972).

A method was developed at the Lawrence Radiation Laboratory in Berkeley to estimate the dose received by an individual accidentally exposed to an accelerator particle beam. The dose estimate is based on measurement of the gross induced activities, primarily ^{11}C, resulting from nuclear interactions of the particle beam with the body tissues of the exposed individual. The activities are measured with a portable NaI crystal γ-ray scintillation detector. To achieve maximum sensitivity and counting statistics, the activity measurements are made in the LRL Health Physics Group's Low-Background Counting Enclosure soon after exposure. Doses were estimated by exposing two tissue-equivalent phantoms, one simulating an arm and the other simulating a torso, to particle beams (protons, and secondary beams of protons, π^+ mesons, and neutrons) of various energies. Results indicate that independent of the part of the body exposed, the beam size (6 to 81 cm^2) or the beam energy from 50 MeV to 6 GeV, the actual dose can be estimated within a factor of 2. Under favorable conditions the lower limit of sensitivity in estimating the dose is less than 1 rem. (auth)

1821 MEASUREMENT AND CONTROL OF DOSE EQUIVALENT TO PATIENTS UNDERGOING WHOLE-BODY NEUTRON IRRADIATION FOR IN VIVO ACTIVATION ANALYSIS. Bush, D. (Univ. of Birmingham, Eng.). Phys. Med. Biol.; 17: No. 1, 32-41(Jan 1972).

The total-body calcium of patients was studied by in vivo activation analysis using neutrons derived from a Li target, bombarded by a cyclotron-produced proton beam. The induced ^{49}Ca activity was detected using a whole-body counter. An account is given of the methods used to control and measure the dose equivalent delivered to patients. The neutron dose equivalent was calculated from readings taken before and during patient irradiations using a neutron rem counter, a Th fission counter, and a BF_3 detector enclosed in a moderator and absorber assembly. Data are presented showing the variation of neutron dose equivalent with depth in phantoms obtained using a prototype personal dosemeter of wide energy response. Dose equivalents for various parts of the body are given for a typical patient irradiation. (auth)

1822 DISTRIBUTION OF PATH LENGTHS THROUGH A POROUS MATERIAL. Clement, C. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., D (London): 5: No. 4, 793-8(Apr 1972).

The distribution of path lengths through a porous material can be examined experimentally by the transmission of particle beams. The assumption is made that there are no correlations in the sizes of pores and in the distances between pores. This leads to a distribution which depends on four basic parameters, namely, the means and variances of the path lengths through and between pores. The first four moments of the distribution are calculated explicitly and are generally related uniquely to the four parameters. (auth)

1823 z^3 CORRECTIONS TO ENERGY LOSS AND RANGE. Jackson, J. D. (Univ. of California, Berkeley); McCarthy, R. L. Phys. Rev., B; 6: No. 11, 4131-41(1 Dec 1971).

Higher-order corrections to the stopping power proportional to z^3 are evaluated. Both close and distant collisions are considered. The energy-loss formula can be written $dE/dx = z^2I + z^3(J_c + J_d)$, where I is the customary lowest-order energy loss and J_c and J_d are the close- and distant-collision parts of the z^3 term, respectively. The close-collision contribution J_c is a relativistic effect, first estimated in unpublished work by Fermi. It has the simple form $J_c = \pi\alpha C/2\beta$, where C is the standard constant multiplying β^{-2} times the Bethe–Bloch logarithm in I and α is the fine-structure constant. At high energies J_c gives a constant-z^3 contribution to the energy loss and causes a range difference ΔR roughly proportional to the range R for stopping particles of the same mass and energy, but opposite charge. For $2 < P/Mc < 20$, $\Delta R/R$ changes by less than $\pm 6\%$ and depends only slightly on the stopping material, varying from 1.9×10^{-3} for carbon to 2.5×10^{-3} for lead for $z = \pm 1$. The distant-collision effect is important only at low velocities. The calculation of this contribution is patterned after a recent work of Ashley, Ritchie, and Brandt, but differs from it in detail. Using a statistical model for the atom, it is found that at low velocities the relative z^3 contribution can be written $J_d/I = F(V)/(Z)^{1/3}$, where Z is the atomic number of the stopping medium and F(V) is a universal function of the reduced velocity variable $V = 137\,\gamma\beta/(Z)^{1/3}$. In the region where J_d/I is appreciable ($1 < V < 10$), F(V) varies as V^{-n} with $n \simeq 2.0$ to 2.5. These results on the z^3 effect at low velocities are in good agreement with available data on comparison of the energy loss of helium ions and protons of the same velocities. Range differences are calculated for carbon, copper, lead, and emulsion absorbers, including the effects of both close and distant collisions. The results are in rough agreement with data on slow-stopping pions and Σ hyperons in emulsions and in good agreement with very recent measurements of fast positive and negative muons. The upper limit of the range of validity of the results is examined in some detail. It is found that the approximations begin to fail for dynamic reasons above $\gamma \simeq 20$ for muons, and presumably also for other heavy particles. (auth)

1824 DETERMINATION OF ENERGY LOSSES FROM THE SPECTRUM OF PARTICLES SCATTERED BY A THICK TARGET. Sirotinin, E. I.; Tulinov, A. F.; Fiderkevich, A.; Shyshkin, K. S. (Moscow State Univ.). Radiat. Eff.; 15: No. 3-4, 149-52(Aug 1972).

A method for determining energy losses from the spectrum of particles scattered by a thick target is presented. By this method the energy losses of protons in Pb, W, Ta, Yb, Ce, Ag, and Mo, and of α particles in W were determined. Results agree with the data of other workers and with theory. (auth)

Radiation Protection Standards

1825 SI UNITS IN RADIATION MEASUREMENT. Jennings, W. A. (National Physical Lab., Teddington, Eng.). Brit. J. Radiol.; 45: No. 538, 784-5(Oct 1972).

The use of the International System (SI) in relation to radiation measurement is discussed and a table is presented, giving present equivalents of derived SI units for the following: activity, absorbed dose, absorbed dose rate, exposure, and exposure rate. The rem is also considered. Opinions are invited by the British Committee on Radiation Units and Measurements concerning the issues of whether or not to retain some special units for radiation measurements. (UK)

1826 END OF THE RAD? Saxton, H. M.; Trott, N. G. Brit. J. Radiol.; 45: No. 538, 715-16(Oct 1972).

Editorial comment is made, and opinions invited, on the future of the roentgen, the rad and the curie, in relation to the SI system and the possible recommendations of the ICRU to the General Conference of Weights and Measures. (UK)

Shielding Calculations and Theory

1827 (CONF-721018–3) RADIATION SHIELDING INFORMATION CENTER (RSIC). A UNIFYING FORCE IN THE INTERNATIONAL SHELDING COMMUNITY. Maskewitz, B. F.; Trubey, D. K.; Roussin, R. W.; Clark, F.H. (Oak Ridge National Lab., Tenn.). 1972. 11p. Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The Radiation Shielding Information Center is a technical institute serving the international shielding community. It acquires, selects, stores, retrieves, evaluates, analyzes, synthesizes, and disseminates information on shielding and ionizing radiation transport. Computer codes and computer-readable nuclear data are treated as an integral part of this work. Problems which hinder code exchange are alleviated by scientists making new development available and therefore open to scrutiny and improvement. Through free and open exchange of shielding information the entire international shielding community can progress rapidly as a unit to advance the state of the art. (auth)

1828 (LA-DC–72-1129) USE OF LAPHANO FOR GAMMA-RAY SHIELDING STUDIES. Dudziak, Donald J. (Los Alamos Scientific Lab., N. Mex.). 1972. 31p. (CONF-721027–1). Dep. NTIS.

From Seminar-workshop on shielding programmers; Ispra, Italy (16 Oct 1972.

The LAPHANO theory and algorithms are reviewed briefly. Detailed input instructions for LAPHANO, computer requirements, and discussion of a sample problem are given. The input format is listed and a sample problem input and output are included. (M.H.R.)

1829 EVALUATION OF GAMMA-RAY SHIELDING CALCULATIONS AND DETERMINATION OF SHIELDING PARAMETERS WITH BREMSSTRAHLUNG RADIATION. Rodriguez, L. F.; Shapiro, A. (Univ. of Cincinnati). Nucl. Sci. Eng.; 49: No. 3, 349-57(Nov 1972).

Experimental methods which utilize incident bremsstrahlung radiation were developed for rigorously evaluating gamma-ray shielding calculational methods and for determining gamma-ray shielding design parameters over a continuous energy span. Comparisons between experimentally determined double differential transmitted spectra, i.e., the spectra as a function of energy and angle, with corresponding calculated transmitted spectra, provide a rigorous test of the calculation. Additionally, by varying the maximum energy of the incident bremsstrahlung radiation, the kernel governing the angle and energy distribution of the transmitted photons can be unfolded from the spectra. A knowledge of this kernel allows calculations to be made of other parameters, such as buildup factors, transmitted doses, etc. Reasonably accurate kernels were obtained by subtracting out the contribution due to single collisions, and by smoothing the remaining multicollision component by applying Cook's least structure analysis. To establish the methods, collimated beams of bremsstrahlung radiation were directed against an iron slab and the experimental results were compared to those obtained from the multigroup Monte Carlo code MORSE. Transmission measurements were taken at angles of 0, 30, and 60° from the incident direction. After modifying the estimator subroutine in MORSE, the spectral agreement obtained was excellent. The kernels obtained by inputting an incident constant group unit source in MORSE agreed favorably with those obtained experimentally from incident bremsstrahlung spectra. (auth)

1830 DETERMINATION OF GAMMA-RAY KERNELS FROM BREMSSTRAHLUNG RADIATION. Rodriguez, Luis Felipe. Cincinnati; Univ. of Cincinnati (1972). 164p. University Microfilms Order No. 72-22,399.

Thesis.

Experimental techniques for rigorously evaluating gamma shielding calculations and for determining photon kernels utilizing incident bremsstrahlung radiation were developed. The University of Cincinnati betatron was used to produce collimated beams of bremsstrahlung radiation whose maximum energy could be continuously varied from 1 to 8 MeV. The pulse-height spectra produced by photon beams normally incident on a 4-inch-thick iron slab, and the spectra transmitted through the slabs at angles of 0, 30, and 60° from the incident beam direction were measured. A lead-shielded 5″ × 4″ NaI scintillation detector connected to a multichannel analyzer was used to measure the pulse-height spectra. The photon spectra were unfolded from the pulse height spectra by a matrix iteration method. The experimental spectra were compared with the results given by the computer code MORSE, a

multigroup Monte-Carlo code obtained from the Radiation Shielding Information Center at Oak Ridge. Initially, the agreement between the MORSE spectra and the experimental spectra was not good. The subroutine in MORSE which estimates the probability that a photon would reach the detector after a collision depended upon a Legendre polynomial expansion for the differential scattering cross section. For gamma rays, unless this expansion is carried out to very high order (e.g., P_{25}) the angular spectra will be inaccurate. The subroutine was modified to use the expression for the Klein–Nishina cross section directly, i.e., without a polynomial expansion, and excellent spectral agreement was achieved. This is an especially rigorous test, since both energy and angular variations over a relatively large range were compared. By taking measurements at varying bremsstrahlung end point energies, the kernel governing the energy and angular distribution through the slab could be unfolded from the spectral data. These kernels were compared to kernels obtained from inputting mono-energetic sources into MORSE. After removing the single collision contribution to the spectra, and applying Cook's least structure smoothing procedure to the remaining multicollision portion, good agreement between the kernels deduced from the experimental spectra and the MORSE kernels was obtained. (Diss. Abstr. Int., B)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 96, 183, 404, and 853–856.

1831 (JUL–866-FF) DEFECT PRODUCTION IN ELECTRON-IRRADIATED GOLD BETWEEN 5 AND 220°K. Schepp, H.-E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). Jun 1972. 115p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Highly purified samples of gold were irradiated with electron beams at temperatures between 5 and 220°K. Below 5.8°K, approximately 15% of all defects were closely neighboring pairs, while 85% of the interlattice atoms were produced as crowdions that diffused one-dimensionally and were trapped. Irradiation above 30°K produced only trapped crowdions. The continuous recovery observed between 30 and 220°K was explained as thermally activated release of crowdions from their traps. (H.B.G.)

1832 GROWTH OF NITRIDED SURFACE LAYERS BY ION BOMBARDMENT. Winters, H. F. (IBM Research Lab., San Jose, Calif.). J. Appl. Phys.; 43: No. 11, 4809-11(Nov 1972).

It is shown that bombardment of a tungsten surface with 300- and 450-eV nitrogen ions produces an altered surface layer whose saturation concentrations are 8×10^{15} and 9×10^{15} nitrogen atoms/cm^2, respectively. Mechanisms involved in the formation and decomposition of these surface layers are discussed. (auth)

1833 USE OF DIVERGENT-BEAM X-RAY DIFFRACTION TO MEASURE LATTICE EXPANSION IN LiF AS A FUNCTION OF THERMAL-NEUTRON DOSE UP TO 6×10^{16} NVT. Yakowitz, Harvey (National Bureau of Standards, Washington, D. C.). J. Appl. Phys.; 43: No. 11, 4793-4(Nov 1972).

The lattice expansion of LiF was measured by means of the divergent-beam (Kossel) x-ray-diffraction method at three levels of thermal-neutron dose, 0.45, 2, and 6×10^{16} nvt, respectively. The lattice parameter of LiF increases due to the production of Frenkel defects resulting from the $^6Li(n,\alpha)^3H$ reaction. At 6×10^{16} nvt, the lattice expansion was found to be $0.13 \pm 0.02\%$, which is in good agreement with previously reported values. (auth)

1834 LUMINESCENCE FROM IMPURITIES AND RADIATION DEFECTS IN CdSe AND CdS. Arora, B. M.; Compton, W. D. (Univ. of Illinois, Urbana). J. Appl. Phys.; 43: No. 11, 4499-4507(Nov 1972).

CdSe and CdS platelets annealed in NaCl atmosphere show strong emission attributed to donor–acceptor pair recombination with chlorine as a substitutional donor and sodium as a substitutional acceptor. Upon irradiation with fast neutrons, CdSe:NaCl platelets exhibit a new emission band centered at about 7050 Å. Chlorine-doped CdSe platelets show a weak emission band at the same wavelengths, whose strength increases upon irradiation with neutrons. It is suggested that this new emission also arises from donor–acceptor pair recombination with the donor being a substitutional chlorine and the acceptor a cadmium vacancy associated with a substitutional chlorine. (auth)

1835 RECOMBINATION STUDIES ON GAMMA-IRRADIATED N-TYPE SILICON. Curtis, O. L. Jr.; Srour, J. R.; Rauch, R. B. (Northrop Corporate Labs., Hawthorne, Calif.). J. Appl. Phys.; 43: No. 11, 4638-46(Nov 1972).

Results of a detailed investigation of recombination in phosphorus-doped ^{60}Co γ-irradiated n-type silicon are reported. An analytical procedure is employed for the determination of parameters associated with recombination centers. Properties of two recombination centers are determined. The level most important at low excess densities is determined to be 0.40 ± 0.015 eV from the conduction band. c_n varies as $\exp(0.06 \pm 0.015\ eV/kT)$, and c_p varies as $\exp(0.03 \pm 0.015\ eV/kT)$. The capture-probability ratio c_p/c_n varies from 8 ± 1 at 303°K to 9.5 ± 1 at 370°K. The level dominant at high excess densities is placed at 0.21 ± 0.03 eV below the conduction band with $c_n \sim \exp(0.01 \pm 0.01\ eV/kT)$ and $c_p \sim \exp(-0.05 \pm 0.03\ eV/kT)$. The corresponding capture probability ratio, c_p/c_n, varies from ~5.6 at 303°K to ~8 at 370°K. Based upon dependence on phosphorus concentration and annealing behavior, the deeper level appears to belong to the E center. There is some evidence that the other level is also associated with phosphorus-containing defects. (auth)

1836 EFFECTS IN THE PROTON BOMBARDMENT OF NaF CRYSTAL. I. MEASUREMENT OF THE AVERAGE PROJECTED RANGE. Kubo, Kazuko (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 33: No. 5, 1401-6(Nov 1972).

NaF crystals were bombarded with protons of energy from 0.6 to 2 MeV at somewhat high temperatures, to produce Na colloids in the proton-penetrated zone. The average projected range of protons was measured by thickness of the colloid layer. The range–energy relation has little proton channeling and seems to be that for random directions. The microscopic cleavage profile in the beam direction included colored-zone, separate colloid layers, microcracks, and turning of the cleavage steps, which appears to have close relation with the effects of resonant $^{19}F(p,\alpha)^{16}O$ reactions as well as the proton penetration itself. Their locations coincide with the range ends of the protons of incident and resonant energies and of the α particles produced at 340.5-keV resonance. Hydrogen and oxygen with protons and α particles may contribute to the occurrence of a local strain to initiate cracks. (auth)

1837 EFFECT OF ION BOMBARDMENT OF CRYSTALLINE AND AMORPHOUS FILMS OF As_2Se_3 AND Se. Olley, J. A.; Yoffe, A. D. (Cavendish Lab., Cambridge, Eng.). J. Non-Cryst. Solids; 8-10: 850-6(Jun 1972).

The optical absorption of crystalline and amorphous films of As_2Se_3 and Se was monitored during heavy-ion bombardment at various temperatures and upon subsequent annealing. The increases in absorption upon irradiation of the amorphous films are explained in terms of the increases in the concentration of unsatisfied bonds. The interpretation is extended to explain annealing experiments on amorphous semiconductors. (auth)

1838 RADIATION-INDUCED CHANGE IN THE ELECTRIC CONDUCTIVITY OF CALCIUM FLUORIDE. Zavadovskaya, E. K.; Fedorov, V. A.; Lisitsyna, L. A.; Lisitsyn, V. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 5, 167-8(1972). (In Russian).

The effect of irradiating (at about 30°C) a $10 \times 10 \times 0.4$ mm^3 specimen of CaF_2 with 4.5-MeV protons on the electric conductivity over the temperature range 30 to 500°C was investigated. Between 30 and 100°C, irradiation with protons caused an increase in the conductivity, and between 100 to 400°C a decrease. The change in conductivity was associated with a decrease in the capacity of the source of anion vacancies. (K.S.W.)

1839 THERMOLUMINESCENCE OF γ-IRRADIATED GLASS ACTIVATED BY RARE EARTH IONS. Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 99-100(1972). (In Russian).

Spectral curves of thermoluminescence in the visible region were constructed for silicate glass containing trivalent ions of Pr, Sm, Eu, Tb, and Dy, and irradiated at 77°K by γ radiation from ^{60}Co for 10^6-R doses. Luminescence of the glass was measured with a spectrograph; the plotted curves consisted of families of low-temperature peaks at about 175°K and high-temperature peaks at about 475°K. The presence of Tb or Dy ions intensified the low-T peaks but weakened the high-T peaks; Eu ions failed to produce luminescent peaks. (K.S.W.)

1840 EFFECTS OF THERMAL-NEUTRON IRRADIATION ON AMORPHOUS-SILICON FILMS. Adler, D.; Bowen, H. K.; Ferrao, L. P. C.; (and others) (Massachusetts Inst. of Tech., Cambridge). J. Non-Cryst. Solids; 8-10: 844-9(Jun 1972).

Thin films of vapor-deposited amorphous silicon were subjected to integrated thermal-neutron fluxes up to 8.3×10^{18} n/cm^2. Provided the films had been annealed at 300°C prior to the irradiation, only very small effects on the electrical and optical properties were observed. Results provide some evidence in favor of the predominance of thermally activated hopping conduction in the vicinity of the Fermi energy in such films. (auth)

1841 ELECTRICAL CONDUCTIVITY OF MICROLITE AT ELEVATED TEMPERATURES IN A REACTOR RADIATION FIELD. Gulyamov, U. G.; Zakharov, G. E.; Kostyukov, N. S.; Polyak, Yu. V.; Sokolov, A. P. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 83-6(1972). (In Russian).

This material, a class of corundum ceramic, contained essentially 99.4% Al_2O_3, 0.57% MgO, 0.03% Fe_2O_3, and traces of alkali metal oxides; it was 99% crystalline with 1% vitreous phase present. The electric conductivity was investigated after exposure to a flux of 1.3×10^{13} neutrons/cm^2 · sec in the temperature interval 100 to 800°C. A small lowering of the specific conductivity was observed over this interval. (Editor's note: This material, which the author's choose to call "microlite," is not what is commonly known as microlite.) (K.S.W.)

1842 ELECTRON SPIN RESONANCE STUDY OF GRAPHITE IRRADIATED WITH HEAVY IONS. Virmani, Y. P.; Zimbrick, J. D.; Zeller, E. J. (Univ. of Kansas, Lawrence). Carbon; 10: No. 5, 613-20(Oct 1972).

Electron spin centers were produced in crystalline graphite samples irradiated with 1-MeV protons (p^+), deuterons (d^+), and

helium ions ($^4He^{2+}$) at 77°K. Under these conditions, the linear energy transfer (LET) increased in the sequence $p^+ < d^+ < {}^4He^{2+}$. The paramagnetic properties were studied by electron spin resonance (ESR) spectroscopy. Measurements of ESR line width as a function of radiation dose suggest that the centers are present in sufficiently high local concentrations to interact with each other. Measurements of ESR line widths and signal intensity as a function of sample temperature indicate that the spins produced by the radiation are of a localized nature as opposed to conduction type electrons in unirradiated graphite. These data also are consistent with the hypothesis that electrons are trapped at interstitial-defect sites in the tracks left by the bombarding particles. (auth)

1843 INFRARED ABSORPTION STUDY OF ION-IMPLANTED SILICON. Morgan, Hugh Thomas. Blacksburg, Va.; Virginia Polytechnic Inst. and State Univ. (1972). 87p. University Microfilms Order No. 72-23,842.

Thesis.

Single-crystal, beryllium-doped silicon was implanted with varying doses of 1.8- to 3.5-MeV hydrogen ions. Infrared-absorption spectra of the implanted samples display two new sets of absorptions when recorded at temperatures less than 20°K. These absorptions have been attributed to two different beryllium–hydrogen acceptor centers formed in the silicon crystal. These new centers are called set I beryllium–hydrogen complex and set II beryllium–hydrogen complex. The absorptions associated with these complexes are recorded and studied as a function of initial beryllium content as well as post implantation heat treatment. From these data the ionization energies for the set I and set II centers were determined to be 92.0 and 43.4 meV, respectively, and a model for each center was proposed which best accounts for the experimental observations. A thorough study of single-crystal silicon implanted with energetic nitrogen ions is also reported. The electrical and optical properties of different samples were monitored before and after implantation. Although it was concluded that nitrogen acts as a donor impurity in silicon, no evidence of a characteristic donor spectrum was observed. However, the infrared absorption spectra of samples which received greater than 10^{17} N ions/cm^2 side were drastically altered. These changes are indicative of a reflecting interface formed beneath the sample surface at a depth near the range of the implanted ions. (Diss. Abstr. Int., B)

1844 CHANNELING OF POSITRONS OF 1 GeV ENERGY. Morokhovskii, V. L.; Kovalenko, G. D.; Grishaev, I. A.; (and others) (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 16: No. 3, 112-14(5 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 3, 162-4(5 Aug 1972).

The channeling of positrons of ~28-MeV energy in a silicon crystal along the [110] axis was observed by Walker et al., (Phys. Rev. Lett., 25: 5(1970)). Here, results of a study show for the first time that the effect of channeling of positrons in a crystal exists also at 1 GeV. The difficulty previously existed of generating high-energy positron beams with small divergences. A beam of positrons with energy 1 GeV and divergence $\leq 2 \times 10^{-4}$ rad was directed on a single-crystal silicon target mounted in a goniometer. The goniometer made it possible to rotate the crystal in the vacuum chamber of the accelerator about all three axes, with a reading accuracy 5×10^{-5} rad. The silicon crystal was in the form of a plate 0.64 mm. The normal to the plane of the plate made an angle ~1° with the [110] axis. The crystal was oriented relative to the beam in such a way that the [110] crystal axis was directed along the beam axis, and the [001] axis was oriented along the goniometer axis that was perpendicular to the beam direction. (J.C.W.)

1845 RECOVERY OF ELECTRICAL RESISTIVITY IN NEUTRON-IRRADIATED URANIUM MONOCARBIDES. Matsui, H. (Nagoya Univ., Japan); Kirihara, T.; Ohmichi, T. J. Nucl. Sci. Technol. (Tokyo); 9: No. 10, 618-19(Oct 1972).

The recovery of the increased electric resistivity in arc-melted UC irradiated with 4×10^{16} nvt (thermal) was studied. Three steps up to 800°C were observed in the resistivity change for this specimen with both 1 and 2°C/min heating rates and for a specimen irradiated to 9×10^{16} nvt and pulse-annealed. Similar results were observed for powdered UC obtained from arc-melted UC after 10^{16} nvt irradiation. Activation energies of 0.4, 1.0, and 1.9 ± 0.1 eV were estimated for the steps around 170, 400, and 650°C, respectively. The first stage may be attributed to movement of interstitial atoms, and the second and third stages to migration of C and U vacancies, respectively. (D.L.C.)

1846 ELECTRON TRAP ANALYSIS IN THERMOLUMINESCENT LiF CRYSTAL. Park, Dae Yoon (Atomic Energy Research Inst., Seoul); Ko, Chung Duck; Lee, Sang Soo. J. Korean Nucl. Soc.; 4: No. 3, 214-22(Sep 1972).

In the optical-grade LiF crystal, the electron traps corresponding to the thermoluminescence (TL) glow peak develop as irradiation dose is increased. Originally the electron trap of the crystal has two levels but as the dose reaches to the order of 10^4 R, it attains five levels as observed in the TL glow curves. The five trap depths are determined from the glow peak temperatures for two different heating rates, θ = 6.6°C/sec and 3.4°C/sec. The electron trap depths have the following values E_1 = 0.79 eV, E_2 = 0.93 eV, E_3 = 1.02 eV, E_4 = 1.35 eV, E_5 = 1.69 eV. The special feature of thermoluminescence of optical-grade LiF is that the traps, except E_1 and E_2 corresponding to the 120°C glow peak and the 150°C glow peak for θ = 6.6°C/sec, have severe thermal instability, i.e., E_3, E_4, and E_5 levels disappear during bleaching process. These defects in the optical-grade LiF crystal seem annealed out during the course of TL measurement. The fresh or long-time-unused LiF(Mg) crystal shows only two glow peaks at 170 and 230°C for θ = 6.6°C/sec, but upon sensitization with γ-ray irradiation, it converts to the six glow peak state. The four electron traps, E_1, E_2, E_3, and E_6, created by γ-ray irradiation and corresponding to the glow peaks at 100°C, 130°C, 150°C, and 290°C are stable and not easily annealed out thermally. The sensitization essentially required for a LiF(Mg) dosimeter is to give the crystal the stable six levels in the electron trap. In optical-grade LiF, a logarithmic plot of total TL output versus γ-ray dose has more supralinearity than that of LiF(Mg). However, for the height of the 120°C glow peak (θ = 6.6°C/sec), the curve becomes close to that of LiF(Mg). (auth)

1847 EFFECTS OF GAMMA RADIATION ON THE CURRENT INSTABILITIES CAUSED BY RECOMBINATION CENTERS IN n-GaAs CRYSTALS. Elsharkawi, A. R.; Kao, K. C. (Univ. of Manitoba, Winnipeg). Radiat. Eff.; 15: No. 3-4, 277-8(Aug 1972).

In an investigation into high-field transport phenomena in III–V compound semiconductors, the effect was studied of gamma radiation on the current instabilities in oxygen-doped n-GaAs crystals. To avoid heating the sample, staircase pulses in conjunction with a curve tracer were used to measure the current–voltage (I–V) characteristics. It was found that, before and after gamma irradiation, the I–V characteristics are S-shaped with a current-controlled negative differential resistance (n.d.r.) region. Before the onset of the n.d.r. region, the current at a given voltage increases slightly with increasing radiation dose. After the onset of the n.d.r. region, the current at a given voltage decreases slightly with increasing radiation dose. Gamma radiation reduces the frequency and amplitude of current oscillations. A mechanism for the observed effects is proposed. (UK)

1848 VOID FORMATION IN IRRADIATED COPPER, NICKEL, AND COPPER–NICKEL ALLOYS. Brimhall, J. L.; Kissinger, H. E. (Battelle-Northwest, Richland, Wash.). Radiat. Eff.; 15: No. 3-4, 259-72(Aug 1972).

The formation of voids during neutron irradiation of pure nickel, pure copper, and nickel–copper alloys was studied. Part I concerns the fluence dependence of void parameters in pure copper and nickel irradiated at 285°C and at very low fluences. The void swelling at these low fluences is not a linear function of the fluence, but varies approximately as $(\phi t)^2$ in pure copper and $(\phi t)^{2.7}$ in pure nickel. An attempt was made to correlate the results with a homogeneous void nucleation theory. Part II concerns the void formation in copper–nickel alloys. In general, voids do not form in these alloys at least up to fluences of 2.4×10^{19} n/cm^2. The lack of voids in the high copper alloys is explained by increased recombination of point defects. The lack of voids in the high nickel alloys is better explained by a vacancy-trapping model. (auth)

1849 HIGH FLUENCE NEUTRON IRRADIATION DAMAGE IN COPPER–10 WT. PERCENT ALUMINIUM AND COPPER. Wolfenden, A. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 15: No. 3-4, 255-8(Aug 1972).

Annealed specimens of Cu–10 wt % Al and high-purity copper were irradiated to a fast (>0.1 MeV) fluence of about 1.3×10^{22} neutrons/cm^2 at an estimated irradiation temperature of 175 ± 25°C. Transmission electron microscopy was used to examine the structural damage after irradiation. In the alloy, equiaxed and elongated voids were seen whose distribution was nonuniform. The voids, often associated with particles and dislocation tangles, were present in number densities of about 10^{11}/cm^3 and had sizes up to about 3500 Å (equiaxed) or about 4500 Å (elongated). Arrays of tangled dislocations and small dislocation loops were also observed in the irradiated alloy. The only radiation damage seen in the high-purity copper was a multitude of small dislocation loops. Explanations of these observations near the lower limit (~0.3 T_m) of the temperature range for void formation in face-centered cubic metals are offered in terms of differences in the starting microstructures of the specimens. (auth)

1850 SEARCH FOR A CHANNELLING EFFECT IN SINGLE CRYSTAL BEAM FOIL SPECTROSCOPY. Astrup, G.; Olsen,

J. S. (Univ. of Copenhagen). Radiat. Eff.; 15: No. 3-4, 205-7(Aug 1972).

Light emission from a 60-keV He^+ beam excited by an 80-Å-thick single-crystal gold film was measured. The line intensity was monitored as a function of crystal orientation (parallel and near to the ⟨100⟩ string). To avoid the influences of forward scattering, a special experimental arrangement was devised. The results demonstrate that there is little, if any, effect of channeling in single-crystal beam–foil spectroscopy. (auth)

1851 ELECTRON-IRRADIATION INDUCED PRODUCTION AND THERMAL ANNEALING OF DAMAGE IN α-TIN. Myhra, S.; Gardiner, R. B. (Univ. of Queensland, St. Lucia, Australia). Radiat. Eff.; 15: No. 3-4, 209-16(Aug 1972).

Samples of α-tin were bombarded at liquid helium temperatures by electrons in the energy range 0.5 to 1.0 MeV. Large changes in the dc resistance were observed. From the energy dependence of the damage rate, a threshold displacement energy of 12 ± 1 eV was deduced, and the shape of the damage rate vs energy curve indicated that Frenkel pair defects were introduced. Isochronal annealing resulted in three distinct annealing stages in the temperature range 20 to 50°K. Tentative activation energies for the stages were 0.06 to 0.115 eV, depending upon the assumed order of kinetics. There is evidence that the recovery is due to electronic transitions between the L_6, Γ_8, and one or more extrinsic energy levels. (auth)

1852 STRUCTURAL DAMAGE AND ITS ANNEALING RESPONSE IN NEUTRON IRRADIATED MAGNESIUM. Jostsons, A.; Farrell, K. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 15: No. 3-4, 217-25(Aug 1972).

Transmission electron microscopy and immersion density techniques were used to characterize the nature and extent of radiation damage in zone-refined and commercial-purity magnesium irradiated to 1.7×10^{21} neutrons/cm^2 (>0.1 MeV) at about 75°C. Swelling from radiation-induced voids was 1.9 and 0.7%, respectively, for the high-purity and commercial magnesium. This difference was caused by larger voids in the zone-refined material. The voids had a nonequiaxed shape, being bounded by {0001}, {10$\bar{1}$0}, and {10$\bar{1}$1} and were flattened in ⟨0001⟩, but the larger voids were more equiaxed. There was pronounced clustering of voids on {0001} planes. The irradiation-induced dislocation structure was also clustered on the basal planes. This dislocation structure is deduced to consist of a complex tangle of 1/6 ⟨20$\bar{2}$3⟩ partial dislocations and their associated stacking faults. During postirradiation annealing, voids began to anneal out in 1 hr at 150°C and were eliminated in 1 hr at 320°C. The smaller voids as well as voids near grain boundaries disappeared first. Slow annealing of voids near some grain boundaries suggested that not all grain boundaries are equally good sinks for vacancies. Voids also became more equiaxed during annealing. Stacking faults were eliminated before the voids disappeared, and the dislocations formed networks. Annealing treatments at 500°C or higher caused the appearance of gas bubbles. (auth)

1853 ELECTRICAL MEASUREMENTS ON SILICON LAYERS IMPLANTED WITH 50 keV PHOSPHORUS IONS. Andersson, A.; Swenson, G. (Chalmers Tekniska Hoegskola, Goeteborg). Radiat. Eff.; 15: No. 3-4, 231-41(Aug 1972).

Silicon single crystals were implanted at room temperature with 50-keV phosphorus ions at doses between 10^{13} and 10^{15} ions/cm^2. After annealing treatments, the number of carriers and the carrier mobility were measured at temperatures between 77 and 295°K. For the implant that received 10^{14} ions/cm^2, the measurements were extended down to 4°K. The depth distribution of the number of carriers and of the carrier mobility was also studied. After annealing treatments at 550°C or at higher temperatures, the implants with 10^{15} ions/cm^2 had carrier depth distributions which were in good agreement with the Lindhard–Scharff–Schiött theory for amorphous materials. However, for the implants with 10^{14} ions/cm^2, the carrier profiles diverged strongly from this theory. A discussion is given of possible errors in the electrical measurements on ion-implanted semiconductors. (auth)

1854 AMORPHIZATION OF GERMANIUM CRYSTALS DURING ION BOMBARDMENT. Gusev, V. M.; Guseva, M. I.; Starinin, C. V. (Inst. of Atomic Energy Moscow). Radiat. Eff.; 15: No. 3-4, 251-4(Aug 1972).

Germanium single-crystal amorphization doses D_a, during bombardment with 30-keV ions of different species ($5 \leq Z_i \leq 83$) are determined by a high-energy electron-diffraction method. The experimental dependence of the amorphization dose on ion atomic number is compared with the theoretical one, obtained on the assumption that the amorphous layer is formed as a result of an increase in the number and dimensions of microscopic amorphous zones produced by the bombarding ions. The character changes of the diffraction patterns for the lightest ions with dose differs from that for heavier ions. The temperature dependence of the amorphization dose for phosphorous ion bombardment in the range $10°C \leq T \leq 250°C$ is measured and compared with existing theories. (auth)

1855 ION IMPLANTATION DAMAGE AND ANNEALING IN GaP. Carter, G. (Univ. of Salford, Eng.); Whitton, J. L. Radiat. Eff.; 15: No. 3-4, 143-8(Aug 1972).

40-keV Te ions were implanted in GaP at room temperature and measurements of the Ga and P disorder were made using the technique of Rutherford backscattering of 1-MeV He^+ ions. Backscattering spectra for disordered binary crystals show that, within the limits of sensitivity of the measurements, the degrees of disorder of both atomic species are equal. Attempts to anneal highly disordered crystals by either a 1-MeV He^+ probe beam or a 10-keV He^+ beam met with no success, both leading to enhanced damage. (auth)

1856 ENHANCED DIFFUSION AND THE DOSE RATE DEPENDENCE OF Sb AND P IN Si BY PROTON IRRADIATION. Ohmura, Y.; Mimura, S.; Kanazawa, M.; Abe, T.; Konaka, M. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Radiat. Eff.; 15: No. 3-4, 167-74(Aug 1972).

Enhanced diffusion of both diffused impurities and n^+ substrate impurities Sb and P in Si by proton irradiation is observed and analyzed in terms of steady-state excess vacancy distribution. A simple Gaussian diffusion coefficient is employed for the analysis. The standard deviation of 1 μm or a little smaller for the Gaussian diffusion coefficient is reasonable for 300- to 450-kV proton irradiation at 900°C. The diffusion coefficients obtained for both diffused P and substrate P in the epitaxial wafer are not proportional to the proton beam density but show weaker dependence on it for more than 1 μA/cm^2 of proton beam density. It is concluded, from this fact, that the generated vacancy, which is effective to enhanced diffusion, annihilates not only by the first-order annihilation process but also by the higher order process such as the vacancy–interstitial direct recombination. (auth)

1857 ELECTRICAL MEASUREMENTS ON ELECTRON IRRADIATED n- AND p-TYPE GaAs. Pegler, P. L. (Plessey Co., Swindon, Eng.); Grimshaw, J. A.; Banbury, P. C. Radiat. Eff.; 15 No. 3-4, 183-93(Aug 1972).

Hall effect and resistivity measurements were made on undoped n-type and Cd-doped p-type GaAs crystals irradiated with electrons at 287°K. For 1-MeV irradiations, the dose dependence of carrier removal and mobility in n-type suggests that a defect energy level at $E_c - 0.12 \pm 0.015$ eV was introduced by irradiation and was the upper level of a doubly charged acceptor. A donor level was also found in n-type at approximately $E_c - 0.20$ eV, and deeper acceptor levels were also introduced. In p-type, a similar study located a radiation-introduced level at $E_v + 0.11 \pm 0.015$ eV, which could be a singly or doubly ionized donor. Measurements of the carrier removal rate in p-type as a function of beam energy were in good agreement with those previously reported for n-type, thus confirming the displacement energy of 17 to 18 eV. It is suggested that the majority of displacement events gave rise to electrically active defects. (auth)

1858 LOW ANGLE SCATTERING OF 275 keV He^+ IONS FROM A TUNGSTEN CRYSTAL SURFACE. Marwick, A. D.; Thompson, M. W.; Farmery, B. W.; Harbinson, G. S. (Univ. of Sussex, Brighton, Eng.). Radiat. Eff.; 15: No. 3-4, 195-204 (Aug 1972).

Helium ions of 275 keV were scattered at glancing angles from the flat {110} surface of a tungsten single crystal. The angular distribution of the scattered particles in the plane of incidence was measured, as well as their energy spectrum. The energy spectrum had the shape of a skewed peak, and its low-energy tail became more pronounced when a low-index direction lay in the surface in the scattering plane. This is ascribed to channeling of the projectiles in the surface. The angular distribution of the scattered particles shows roughly specular reflection behavior, and it is shown that this is expected whenever the surface may be described as an array of continuum potentials, in which transverse energy is conserved. The scattering of the helium is influenced by the structure of the surface, and it is shown that most of the particles observed are scattered from the second atomic layer of the surface into the detector. The most probable energy loss of the scattered particles decreases with increasing scattering angle. The relationship of the experiment to conventional channeling experiments is discussed, and it is concluded that it may yield extra information about the channeling process. (auth)

1859 USE OF VIBRATORY POLISHING FOR THE LOCATION OF ION-BOMBARDMENT INDUCED VOIDS IN METAL FOILS. Mazey, D. J.; Hudson, J. A.; Francis, S.; Whitton, J. L. (Atomic Energy Research Establishment, Harwell, Eng.). J. Microscopy; 96: No. 1, 77-84(Aug 1972).

The technique of vibratory polishing was successfully applied to the controlled removal of surfaces for examination of ion-irradia-

tion damage structure in nickel, a nickel-based alloy, and stainless steel. The application of this technique to the study of voids formed in localized layers in nickel and stainless steel during high-dose 20-MeV carbon-ion irradiation is described. Transmission electron microscopy observations of the vibratory polished surfaces reveal mechanical damage in the form of linear tracks (~100 nm wide) which are produced by the abrasive Al_2O_3 particles used for polishing. These tracks do not prevent observation of irradiation damage structure. An example is shown of a thin (~100 nm edge thickness) foil produced entirely by this mechanical polishing process. It is proposed that this technique will be equally applicable to the preparation of transmission electron microscope specimens from a wide range of metals, from alloys containing second-phase particles, and from ceramics, glasses, and oxides which are not amenable to preparation by chemical or electropolishing. (auth)

1860 VOID FORMATION DURING ANNEALING OF IRRADIATED MOLYBDENUM. Evans, J. H.; Mahajan, S.; Eyre, B. L. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 26: No. 4, 813-20(Oct 1972).

Electron microscope observations are presented to show that voids can be produced in molybdenum neutron-irradiated at low temperature (60°C) by post-irradiation annealing up to 900°C. These results contrast with previous extensive work on molybdenum subjected to similar combinations of irradiation and annealing conditions and in which only dislocation networks and loops have been observed. Some of the conditions required for nucleation of voids are discussed and it is suggested that a critical step in void formation during post-irradiation annealing is the simultaneous migration and association of vacancies and gaseous impurity atoms. Thus the presence of gaseous impurities in solution in the specimen is essential. A simple experiment to test the hypothesis is proposed. Some results on accelerator-irradiated molybdenum are also given which show that voids or cavities are produced under similar conditions to those used in the neutron-irradiation experiments, i.e., low-temperature irradiation followed by high-temperature annealing. (auth)

1861 ANNEALING CHARACTERISTICS OF PHOSPHORUS-IMPLANTED SILICON. Pt. 2. Bicknell, R. W. (Plessey Co. Ltd., Towcester, Eng.). Phil. Mag.; 26: No. 4, 911-27 (Oct 1972).

Silicon samples implanted with 3.13×10^{14} phosphorus ions/cm^2 at 50 and 100 keV were isochronally annealed over the temperature range 600 to 1200°K. Sheet resistivity and sheet Hall measurements were taken and related to first- and second-order thermal reactions governing the increase in conductivity. At selected temperatures, specimens were sectioned by anodic stripping and the impurity profiles obtained. Changes in these were correlated with the activation of the implanted ions in volumes of the crystal characterized by large or small amounts of crystal damage. Four separate thermal activation reactions were identified. These were discussed in terms of vacancy mechanisms and it was shown that the annealing characteristics of all phosphorus-implanted silicon could be explained by using appropriate combinations of these first- and second-order thermal reactions. The effect of thermal diffusion on the shape of the impurity profile was considered and was shown to be negligible below anneal temperatures of 1100°K. (auth)

1862 LATERAL PHOTOVOLTAIC EFFECT IN NITROGEN-IMPLANTED p-TYPE SILICON. Niu, H.; Matsuda, T.; Yamauchi, K.; Takai, M. (Himeji Inst. of Tech., Shosha, Japan). Appl. Phys. Lett.; 21: No. 9, 423-4(1 Nov 1972).

Nitrogen ions (N_2^+) are implanted into p-type Si samples to a dose of 6×10^{14} cm^{-2} at 10 keV. When the samples, annealed at temperatures higher than 535°C, are irradiated nonuniformly, photovoltages are observed parallel to the implanted surface. This lateral photovoltaic effect has confirmed that an n-type layer is formed by nitrogen implantation. The lateral photovoltage is a linear function of the irradiation position. The dependence of the photovoltage on irradiation wavelength (0.70 to 1.40 μ) and on anneal temperature (up to 850°C) was also investigated. (auth)

1863 BEAM-INDUCED LATTICE DISORDER IN CHANNELING EXPERIMENTS ON Si AND Ge. Campisano, S. U.; Foti, G.; Grasso, F.; Rimini, E. (Univ., Catania, Italy). Appl. Phys. Lett.; 21: No. 9, 425-7(1 Nov 1972).

The disorder produced by 0.3-MeV D^+ random bombardment in Si and Ge crystal targets was investigated with 1.5-MeV D^+ channeling measurements. An increase of about 30 to 50% in the ⟨111⟩- and ⟨110⟩-aligned yields of Ge samples was found after a bombardment with a dose of 200 to 300 μC/cm^2. No significant increase was observed in bombarded Si samples. Detailed angular scans suggest a "spread-out" distribution of defects imbedded in the lattice structure. (auth)

1864 DIELECTRIC CONSTANTS OF GAMMA-RAY IRRADIATED $NaNO_2$. Kwun, Sook-Il; Kim, Myung-Sung (Seoul National Univ.). New Phys. (S. Korea); 12: No. 1, 1-4(Mar 1972).

Dielectric constants of gamma-ray irradiated $NaNO_2$ single crystals were measured by a Q-meter method. Measurements were made in the vicinity of the Curie temperature in the frequency range of 50 kHz to 20 MHz. The $NaNO_2$ single crystal was irradiated by ^{60}Co (25 kCi) to 1.17×10^8, 2.08×10^8, 4.68×10^8, and 1.88×10^9 r. The sample furnace specially designed to reduce the mechanical strain on the sample and to maintain uniform temperature across the sample was used. It was found that the Curie temperature of the irradiated $NaNO_2$ crystal was shifted to lower temperature as the gamma-ray doses increased. The frequency dependence of the dielectric constant of the irradiated crystal was examined at various doses of irradiation. The results are interpreted in terms of the broken-bond model. (auth)

Physical Properties

Refer also to abstracts 96, 183, 611, 635, 816, and 1619.

1865 SOME THEORETICAL ASPECTS OF SPIN-DISORDER RESISTIVITY OF RARE-EARTH ALLOYS. Yang, T. T.; Robinson, L. B. (Univ. of California, Los Angeles). J. Appl. Phys.; 43: No. 11, 4731-2(Nov 1972).

A theoretical expression for the spin-disorder resistivity of binary rare-earth alloys at temperatures above the magnetic transition point has been derived by Dekker. Some experimental results have been obtained by Bozorth and Suits and also by Yang and Robinson. A comparison of theory and experiment was made in this note. According to Dekker's theory, the spin-disorder resistivity ρ_d for a binary alloy containing two magnetic components can be expressed approximately as $\rho_d = c_1x(1-x) + (c_2 - c_3)x + c_3$, where c_1, c_2, and c_3 are constants and x is the percentage composition of one of the components. The experimental spin-disorder resistivity of the Gd–Dy system conforms to this theoretical expression. The constants c_1, c_2, and c_3 have a theoretical basis. (auth)

1866 ANISOTROPY PARAMETERS AND COERCIVITY FOR SINTERED Co_5Sm PERMANENT MAGNET ALLOYS. Benz, M. G.; Martin, D. L. (General Electric Co., Schenectady, N. Y.). J. Appl. Phys.; 43: No. 11, 4733-6(Nov 1972).

Saturation magnetization, intrinsic coercive force, anisotropy field, and anisotropy constants were determined for a sample of sintered Co_5Sm at 4.2, 77, 300, and 500°K. The relationship between the temperature dependence of the coercivity and the anisotropy parameters is discussed. (auth)

1867 DOMAIN-WALL ENERGY IN COBALT–RARE-EARTH COMPOUNDS. Livingston, J. D.; McConnell, M. D. (General Electric Co., Schenectady, N. Y.). J. Appl. Phys.; 43: No. 11, 4756-62(Nov 1972).

Polarized light metallography was used to study magnetic domain configurations in Co_5Sm, Co_5Y, Co_5Ce, and Co_5Pr as a function of crystal thickness. From measurements of equilibrium domain widths on thin crystals, the domain-wall energy in these compounds is 85, 35, 25, and 40 erg/cm^2, respectively. From surface domain observations on bulk crystals, crude estimates of wall energy were also made for Co_5Nd, Co_5La, and Co_5Gd. From these wall energies and published anisotropy constants, exchange constants, domain-wall thicknesses, and critical single-domain particle sizes were calculated. This critical particle size was found to be larger for Co_5Sm and Co_5Gd than for the other compounds, and it was suggested that this may partly explain why high coercive forces are more easily attained in powders of these two compounds. (auth)

1868 ELECTRICAL RESISTIVITY OF EXCHANGE-ENHANCED α-CERIUM UNDER PRESSURE. Katzman, Howard; Mydosh, J. A. (Kernforschungsanlage, Juelich, Ger.). Phys. Rev. Lett.; 29: No. 15, 998-1001(9 Oct 1972).

The temperature (1.2 to 80°K) and pressure (3 to 50 kbar) dependences of the electrical resistivity of the exchange-enhanced α phase of cerium were measured. The exchange-enhancement factor decreases with increasing pressure, enabling one to determine the spin-fluctuation resistivity $\rho_{sf}(T,P)$ by subtracting out the phonon resistivity obtained at high pressures where the enhancement becomes relatively smaller. A strong initial T^2 dependence of ρ_{sf} was observed. These results can be interpreted within the framework of the Kaiser–Doniach theory. (auth)

1869 RELATIONSHIP BETWEEN ELECTRICAL RESISTANCE OF ZIRCONIA CERAMICS AND POROSITY. Rutman, D. S.; Maurin, A. F.; Ust'yantsev, V. M.; Taksis, G. A.; Toropov, Yu. S. Refractories (USSR) (Engl. Transl.); 13: No. 1-2, 115-17(1972).

Translated from Ogneupory; 13: No. 2, 49-51(Feb 1972).

The equation for resistivity as a function of the porosity coefficient $\beta(= P/(100-P))$ is written as $\lg \rho = \lg \rho_0 + \alpha\beta$. α is found to be 998.6/T. Logarithmic corrections for the porosity are tabulated for temperatures of 600 to 1600°C. Apparent activation energies are also calculated for specimens of varying porosity. (D.L.C.)

1870 QUASIELASTIC NEUTRON SCATTERING BY HYDROGEN IN TRANSITION METALS. Gissler, W. (EURATOM–CCR, Ispra, Italy). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 770-80(Aug 1972).

The quasi-elastic scattering of slow neutrons by hydrogen in metals is a sensitive method for the investigation of the diffusion process on an atomistic scale. First, a review of the theory of the quasi-elastic neutron scattering by hydrogen in metals is given. Then, some methods to measure the quasi-elastic scattered neutrons are discussed. From measurements of the quasi-elastic line broadening at small momentum transfers, $h\kappa \ll 2\pi/l_j$ (l_j being the hydrogen jump length), the diffusion constant can be determined. Most of the values determined so far are compiled. From measurements of the quasi-elastic line at large momentum transfers, $h\kappa \gtrsim 2\pi/l_j$, details of the jump diffusion process can be obtained. The experiments performed so far on the systems PdH_x, VH_x, TaH_x, NbH_x, and $PdAgH_x$ are discussed. Most of the results do not fit a simple jump diffusion model. It seems to be important to consider the hydrogen motion during the jump phase. (37 references) (auth)

1871 ELECTRONIC STRUCTURE OF HYDROGEN IN METALS. Friedel, J. (Paris Univ., Orsay, France). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 828-31(Aug 1972).

The possible electronic structure of hydrogen in ordinary metals and alloys, transitional metals, and rare earth metals is discussed, with an emphasis on dilute solutions. (18 references) (auth)

1872 MAGNETIC PROPERTIES OF RARE EARTH HYDRIDES. Wallace, W. E. (Univ. of Pittsburgh). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 832-7(Aug 1972).

Magnetic measurements on fully hydrogenated rare earth metals give no indication of magnetic ordering at temperatures down to 4°K, whereas the corresponding elemental rare earth metals, except Pr, order at temperatures ranging from 19°K for Nd to 289°K for Gd. The results are consistent with electric resistivity measurements, which indicate that these hydrides are not metallic conductors. Since the RKKY interaction is inoperative in the hydrides, ordering temperatures are depressed below 4°K. Detailed analysis of the paramagnetic behavior of PrH_2 shows that experiment is consistent only with the anionic model for hydrogen in rare earth hydrides. Rare earth dihydrides, which are metallic conductors, do show magnetic ordering at temperatures ranging from 8°K, for HoH_2 and DyH_2, to 40°K, for TbH_2. EuH_2, alone among the dihydrides that order, becomes ferromagnetic. Rare earth intermetallics of the formula RT_2 and RT_5 (T = Co or Ni) absorb hydrogen with noticeable effect on their magnetic and electrical properties. Virgin samples of $PrCo_2$ and $NdCo_2$ order at 45 and 116°K, respectively. After degassing under ultrahigh-vacuum conditions at elevated temperature, these materials fail to exhibit magnetic ordering down to 4°K. A discussion is given of factors that probably bring about this striking sensitivity to hydrogen concentration. (39 references) (auth)

1873 ELECTRONIC PROPERTIES OF THE RARE EARTH HYDRIDES. Libowitz, G. G. (Kennecott Copper Corp., Lexington, Mass.). Ber. Bunsenges. Phys. Chem.; 76: No. 8, 837-45(Aug 1972).

The rare earth metal dihydrides may be divided into three groups based on their crystal structures: (1) La through Nd dihydrides all have the fluorite structure and form solid solutions with hydrogen up to the composition MH_3; (2) Sm through Lu (excluding Eu and Yb) dihydrides also have fluorite structures but they form hexagonal trihydrides at higher hydrogen contents; and (3) Eu and Yb dihydrides have orthorhombic structures. The electronic properties of all three classes of hydrides are reviewed. The class (3) hydrides appear to be ionic semiconductors. The class (1) and (2) dihydrides are metallic, but their resistivities increase with hydrogen content, and they appear to become semiconductors at high hydrogen contents. The major portion of this paper deals with the class (1) hydrides and, more specifically, with recent studies on cerium hydride. Resistivity measurements on single crystals of cerium hydride showed that it undergoes a composition-dependent metal-to-semiconductor transition at a hydrogen content corresponding to $CeH_{2.8}$. There is no apparent structural change associated with the transition. Recent measurements as a function of temperature revealed that cerium hydride in the composition range $CeH_{2.7}$ to $CeH_{2.8}$ undergoes an electronic transition at about 250°K which probably corresponds to the composition-dependent metal-to-semiconductor transition. In this case, precise x-ray diffractometry disclosed that the cubic fluorite structure became slightly tetragonal below the transition temperature, while neutron diffraction investigations showed that the distribution of hydrogen in the lattice remained random. Electrical resistivity, thermoelectric power, magnetic susceptibility, and crystal structure results are interpreted in terms of bonding and changes in the band structure of the class (1) rare earth hydrides. (50 references) (auth)

1874 LANDAU QUANTUM OSCILLATIONS IN MoO_2 AND WO_2. Vol'skii, E. P.; Teplinskii, V. M. (Inst. of Solid State Physics, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 3, 1048-53 (Sep 1972). (In Russian).

Landau quantum oscillations of the surface impedance at a frequency of 4 MHz are observed in MoO_2 and WO_2 single crystals at liquid helium temperatures and in magnetic fields up to 53 k0e. The dependence of the oscillation frequency on magnetic field direction in three crystallographic planes (010), (001), and (011) of the monoclinic lattice of the compounds is studied. The shape and size of the Fermi surface of the compounds are determined on basis of the data obtained. The effective electron masses are evaluated from the temperature dependence of the oscillation amplitude for a [100] magnetic field direction. (auth)

1875 NONCENTRAL-FORCE MODEL FOR TRANSITION hcp METALS. Kushwaha, S. S.; Kumar, A. (Banaras Hindu Univ., India). Nuovo Cim.; 11B: No. 2, 301-12(11 Oct 1972).

The effective dynamical matrix is split into two parts: (i) the closed-shell part and (ii) the ionic part. The interaction between shells is taken into account by assuming central and angular forces between the shells, whereas the effect of electron gas is incorporated phenomenologically using the Krebs approach. Phonon dispersion relations and Debye characteristic temperature θ for Ti, Hf, and Y were calculated and compared with the available experimental results. (auth)

1876 LATTICE DYNAMICS OF SOME BCC TRANSITION METALS. Behari, J.; Tripathi, B. B. (Indian Inst. of Tech., New Delhi). J. Phys. Soc. Jap.; 33: No. 5, 1207-13(Nov 1972).

A modified angular-force model which takes into account effects of conduction electrons on the lattice vibrations on the basis of Sharma and Joshi model along with the ion–ion central (up to third neighbor) and deLaunay-type angular interaction (up to second neighbor) is considered. The three bcc transition metals alpha-iron, molybdenum, and tungsten were investigated. Calculations for phonon dispersion relations, Debye θ, and Debye–Waller factor show good agreement with experimental data (wherever available) in all cases. (auth)

1877 EFFECT OF MICROSTRUCTURE ON THE ELECTRIC CONDUCTIVITY OF SOLID SOLUTIONS OF ZrO_2–Sc_2O_3. Popil'skii, R. Ya.; Popova, L. N. (Inst. of Chemical Tech., Moscow). Refractories (USSR) (Engl. Transl.); 13: No. 1-2, 103-6(1972).

Translated from Ogneupory; 13: No. 2, 37-40(Feb 1972).

In the region of homogeneous solid solutions for ZrO_2–Sc_2O_3 with a cubic structure of the fluorite type the size of the crystals is, in a certain temperature range, an important factor influencing the conductivity of these materials. The role of this factor is manifest in the position of the maximum on the conductivity isotherms, in the increased conductivity of the fine-grained materials obtained by the hot pressing method, and also in the reduction in the conductivity of ceramics subjected to additional recrystallization. With an increase in the temperature, the influence of grain size and, accordingly, the surface of the intercrystalline boundaries on the conductivity of the ceramics is reduced. This relationship is clearly expressed in a reduction in the activation energy of the conductivity for the fine-grained specimens. With a reduction in the influence of microstructure, the position of the maximum on the isotherms for conductivity is displaced into the region of the compositions of the solid solutions with increased concentration of Sc_2O_3 and, accordingly, an increase in the number of anionic vacancies. (auth)

1878 ELECTRORESISTIVITY OF FIBROUS COMPOSITIONS. Rybal'chenko, M. K.; Ustinov, L. M.; Zhamnova, V. I. (Inst. of Metallurgy, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR, No. 5, 67-70(May 1972). (In Russian).

It is shown theoretically that electric resistivity of fibrous composites on the metal base with a monodirected discrete structure does not depend on the degree of fiber discreteness and is determined by the formula previously deduced for composites with a monodirected continuous structure. Validity of this conclusion was experimentally confirmed on a model composite Cu/W produced by the method of saturation in vacuum. (auth)

1879 ELECTRICAL AND THERMAL TRANSPORT PROPERTIES OF TUNGSTEN AND THE RF SIZE EFFECTS IN POTASSIUM. Wagner, David Kendall. Ithaca, N. Y.; Cornell Univ. (1972). 103p. University Microfilms Order No. 72-27,988.
Thesis.

Low-temperature measurements of ρ and WT (ρ is the electrical resistivity and W is the thermal resistivity) were made in high-purity tungsten single crystals in the absence of a magnetic field. The temperature dependence of ρ and WT is found to be predominantly quadratic, in agreement with observations in other transition metals, and is attributed to electron–electron scattering. The validity of Matthiessen's rule for impurity and boundary scattering is investigated to determine whether the contributions of electron–electron scattering, ρ_e and W_eT, can be separated from ρ and WT. In those samples in which boundary scattering contributes least to to the total resistivities, Matthiessen's rule is approximately obeyed for the electrical resistivity, while deviations are observed for the thermal resistivity. For these samples, the measured values of ρ_e and W_eT yield Lorenz numbers for electron–electron scattering, $L_e = \rho_e/W_eT$, that range from 0.2×10^{-8} to 0.4×10^{-8} $W\Omega/K^2$. Measurements of the high-field transverse electrical and thermal conductivities, σ_{xx} and κ_{xx}, of a high-purity tungsten single crystal are presented for the temperature range 1.5 to 6°K. The magnetic field dependences of the conductivities conform excellently to predictions of high-field semiclassical magnetoresistance theory, provided that thermal conduction by the lattice is taken into account. Results show that the lattice thermal conductivity is proportional to T^2, as expected for a pure metal in which the phonons are scattered principally by the conduction electrons. The temperature dependence of the high-field electrical conductivity σ_{xx}, and the corresponding electronic contribution $(\kappa_e)_{xx}$ to the thermal conductivity κ_{xx} are also measured. Theoretical expressions for these quantities are derived from semiclassical magnetoresistance theory, allowing estimates to be made of the temperature dependence associated with possible low-temperature scattering mechanisms. Difficulties in interpreting the previous zero-field measurements in terms of electron–electron or electron–phonon scattering are discussed. The theory developed is discussed in greater detail and is extended to include a discussion of the longitudinal magnetoresistance. Next, it is shown that several interesting predictions regarding the role of electron–phonon scattering in the magnetoresistance of potassium can be made on the basis of semiclassical theory. Lastly, an assessment is made of the prospect of using the rf size effect to detect anisotropies in the relaxation time in potassium. (Diss. Abstr. Int., B)

1880 ELECTRONIC STRUCTURE OF STOICHIOMETRIC AND NONSTOICHIOMETRIC VANADIUM CARBIDE DETERMINED BY THE METHOD OF AUGMENTED PLANE WAVES. Zbasnik, Jon Paul. Minneapolis; Univ. of Minnesota (1972). 180p. University Microfilms Order No. 72-27,827.
Thesis.

The dependence of band spacing on assumed atomic sphere radii was studied. Self-consistent calculations indicate that the bonding in vanadium carbide is similar to other transition-metal carbides. The energy bands and density of states curves for nonstoichiometric vanadium carbide phases show a marked deviation from rigid band behavior. Results are in excellent agreement with the x-ray emission spectra for vanadium carbide caused by electronic transitions from the valence states to the vanadium 2p and to the carbon 1s core states. The calculations can also be correlated with the composition dependence of the electronic specific heat and Hall coefficient. Using available specific heat data, the superconducting transition temperature of $VC_{0.88}$ is estimated to be 5×10^{-4} °K. (Diss. Abstr. Int., B)

1881 ELECTRONIC PROPERTIES OF VANADIUM NITRIDES. Ajami, Fouad Iskandar. Philadelphia; Univ. of Pennsylvania (1972). 194p. University Microfilms Order No. 72-25,533.
Thesis.

An attempt was made to elucidate the electronic structure of VN by studying some of its properties as a function of nitrogen content. Pure VN samples were prepared by reacting pure V foils in a N_2–Ar mixture at 1200°C. The composition of the samples, in the range $VN_{0.72}$ to VN, was controlled by varying the N_2/Ar ratio. In that range of composition, VN exists in the (fcc) defect structure, with vacancies in the nitrogen sublattice. The lattice constant varied linearly with nitrogen content from 4.06 Å for $VN_{0.72}$ to 4.14 Å for VN. The magnetic susceptibility, superconducting transition temperature, electrical resistivity, Seebeck coefficient, and Hall coefficient were measured. The general behavior of the vanadium nitrides is quite similar to that of transition-metal alloys. The magnetic susceptibility decreases with decreasing nitrogen content, from 266×10^{-6} emu/mole for VN to 116×10^{-6} emu/mole for $VN_{0.72}$ at room temperature. The susceptibility rises very slightly with increasing temperature. The superconducting transition temperature decreases from 8.2°K for VN to 2.1°K for $VN_{0.75}$. These results are explained in terms of a rigid band model. The nitrogen atoms donate electrons to the d band of vanadium. An empirical density of states curve, derived from these measurements, is in reasonable agreement with the band structures calculated for similar compounds. The electrical resistivity increases uniformly with temperature. At low temperatures, the residual resistivity increases from 35 $\mu\Omega$ cm for VN to 90 $\mu\Omega$ cm for $VN_{0.72}$. However, at 1500°K, the resistivity of VN is 60 $\mu\Omega$ cm, which is about one third that of vanadium. Small amounts of oxygen can effect a five-fold increase in the resistivity, and even change the slope of the resistivity/temperature curve. The Seebeck coefficient varies from -2 μ volt/deg to $+7$ μ volt/deg in a complicated fashion. It exhibits a maximum around 1400°K, a minimum at 500°K, and another maximum at cryogenic temperatures. The Hall coefficient is essentially independent of temperature in the range 77 to 600°K for various compositions. It increases from -15×10^{-5} cm^3/C for VN to $+30 \times 10^{-5}$ cm^3/C for $VN_{0.75}$. The large residual resistivity precluded the possibility of any meaningful magnetoresistance measurements. Thus, it was not possible to obtain quantitative information on the Fermi surface from the transport properties. An interesting correlation was found between the calculated density of states curve, obtained from magnetic and superconducting measurements, and the thermodynamic activity coefficients of vanadium and nitrogen. (Diss. Abstr. Int., B)

1882 ELASTIC CONSTANTS AND INTERATOMIC FORCE CONSTANTS OF NIOBIUM–MOLYBDENUM ALLOYS. Hubbell, Wayne C. Houston, Tex.; Rice Univ. (1972). 90p. University Microfilms Order No. 72-24,423.
Thesis.

The three independent elastic constants c_{11}, c_{12}, and c_{44} were measured between –190°C and +100°C for niobium and six niobium–molybdenum alloys. The effects due to compositional changes were found to be far greater than those due to temperature. An anomalous temperature dependence was, however, found for c_{44} in the niobium-rich alloys. The interatomic force constants were analyzed according to two independent approaches. The first method considered central forces between nearest and next-nearest neighbors. The two constants associated with this approach were found to increase monotonically with increasing molybdenum content for the alloy system. This could be associated with the filling of a d-subband near molybdenum in accordance with the theory of Goodenough. The second approach was in terms of Born–von Karmán general interatomic forces and utilized the phonon dispersion curve data of Powell et al. The general force constants were computed for models including interactions out to third and seventh-nearest neighbors. In this method, the sum of the interatomic forces between two given lattice planes was equated to the interplanar force constant as determined by Fourier analysis of the dispersion curves. It was found that the compositional dependence of the general force constants for first and second-nearest neighbors were different from those of the central force model. These general force components were found to increase for the niobium-rich alloys, reach a broad maximum near 50%, and then decrease for the molybdenum-rich alloys. There was still, however, a net increase from niobium to molybdenum. The distant neighbor force constants were found to be non-negligible. It is thought that the behavior of the proximate neighbor forces is strongly dependent on ion–ion interactions which are particularly sensitive to the configuration of d-electrons. However, the details of these interactions are not well understood. (Diss. Abstr. Int., B)

1883 CORRELATION OF WORK FUNCTION OF TRANSITION METAL CARBIDES IN THE REGION OF HOMOGENEITY WITH SURFACE RECOMBINATION OF HYDROGEN ATOMS. Samsonov, G. V.; Podchernyaeva, I. A.; Fomenko, V. S.; (and others) (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 5, 62-6(May 1972). (In Russian).

Temperature dependences of the electron work function and numeric values were obtained for hydrogen surface recombination of coefficients for TiC_x and NbC_x. An essential dependence of φ and γ was found on a number of vacancies in the carbon sublattice of carbides. (auth)

1884 RESISTANCE MINIMUM OF THE KONDO-TYPE IN NON-DILUTE MAGNETIC SYSTEMS. Kuebler, J. (Ruhr-Univ., Bochum, Ger.). Z. Phys.; 254: No. 5, 385-98(1972).

Using Nagaoka's decoupled equations of motion for double-time Green's functions, an approximate integral equation is derived and solved numerically for the self-energy of conduction electrons in intermatallic compounds containing a non-dilute and translationally symmetric system of magnetic rare-earth ions. These latter are assumed to interact with an antiferromagnetic s–f exchange parameter with the conduction electrons. The resistivity is computed and compared with experimental values for $CeAl_2$ and $CeAl_3$. (auth)

1885 STRUCTURE OF ENERGY BANDS OF MONOCARBIDES OF METALS OF GROUPS IV AND V. Potorocha, V. I.; Tskhai, V. A. (Inst. of Chemistry, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR; 203: No. 5, 1118-21(11 Apr 1972). (In Russian).

Energy spectra of transition metal monocarbides (groups IV and V) were calculated from bond strengths. The energy bands are depicted in graphical form for VC, ZrC, NbC, TiC, HfC, and TaC. Histograms were constructed that show the contribution of the atomic states in the band structures of these six monocarbides. (K.S.W.)

1886 TEMPERATURE DEPENDENCE OF THERMAL CONDUCTION COEFFICIENTS OF SOLID SOLUTIONS OF THE NIOBIUM–ZIRCONIUM SYSTEM. Savitskii, E. M.; Sukharevskii, B. Ya.; Baron, V. V.; (and others) (Physical-Technical Inst. of Low Temperatures, Kharkov). Dokl. Akad. Nauk SSSR; 203: No. 5, 1044-6(11 Apr 1972). (In Russian).

The thermal and electric conductivity of Nb–Zr solid solutions was investigated over a wide range of Zr concentrations and the interval of temperature 2 to 300°K. The majority of samples exhibited a maximum in thermal conductivity between 3 and 5°K. The electrical resistance varied greatly with the composition. These results are discussed in terms of the electron component which consistently decreased with increase in the concentration of the solutions. (K.S.W.)

1887 TRANSVERSAL ELECTRICAL PROPERTIES OF THE UNIAXIAL ANTIFERROMAGNETS UAs_2 AND USb_2. Henkie, Z.; Kletowski, Z. (Inst. of Low Temperature and Structure Research, Wroclaw). Acta Phys. Pol.; A42: No. 4, 405-11(1972).

Results are given of electrical resistivity measurements carried out on single-crystal samples of antiferromagnetic UAs_2 and USb_2 at 4.2 to 300°K in an electric field perpendicular to the c-axis, as well as on powder samples at 77 to 500°K. It was found that these compounds exhibit a high anisotropy of the electrical resistivity. The temperature derivative $d\rho/dT$ of the transversal resistivity has a sharp peak at about T_N. Below 60°K the spin disorder resistivity of UAs_2 is governed by spin wave scattering with a spin-wave activation energy of about 51°K, and above 70°K up to T_N it is proportional to T^2. For USb_2 this resistivity is proportional to $T^{\frac{1}{2}}$. (auth)

1888 ELECTRICAL PROPERTIES OF CdO AT HIGH TEMPERATURES. Jarzebski, Z. M.; Muszynska, B.; Oblakowski, J. (Inst. of Material Engineering, Krakow). Acta Phys. Pol.; A42: No. 4, 383-91(1972).

The electric conductivity σ of CdO was measured in the temperature range 970 to 1270°K in conditions of thermodynamic equilibrium between the investigated samples and ambient oxygen in the air under atmospheric pressure. A linear dependence of log σ vs 1/T was observed. From these data and Hall effect measurements at room temperature, the high-temperature Hall mobility was obtained. A good agreement was found between the values of mobility obtained by this method and the conventional one. An analysis of experimental data of electrical properties of ceramic CdO and single crystals of this oxide was also given. (auth)

1889 DEPENDENCE OF THE INSULATOR–METAL TRANSITION IN EuO ON MAGNETIC ORDER. Shapira, Y. (Massachusetts Inst. of Tech., Cambridge); Foner, S.; Reed, T. B.; Birecki, H.; Stanley, H. E. Phys. Lett.; 41A: No. 5, 471-2(23 Oct 1972).

The Hall coefficient in an EuO sample which exhibited an insulator–metal transition was measured at $T \approx 4T_c$ in fields up to 150 kOe. The results indicate that the activation energy does not vary linearly with magnetization, contrary to the conclusion of Penney et al. (auth)

1890 EFFECT OF ZERO-POINT ENERGY ON MAGNETOCRYSTALLINE ANISOTROPY OF THE RARE EARTH METALS. Egami, T. (Univ. of Sussex, Brighton, Eng.). J. Phys., C (London); 5: No. 8, L85-8(27 Apr 1972).

Spin-wave theory of the magnetocrystalline anisotropy was re-examined to incorporate the zero point correction due to the ellipticity of the spin precession. For the sixfold anisotropy of Dy, this correction was found to be very important. (auth)

1891 HIGH MAGNETIC COERCIVITY OF NEODYMIUM– AND DIDYMIUM–COBALT ALLOYS SINTERED WITH Pr AND Sm ADDITIVES. Tsui, J. B. Y.; Strnat, K. J.; Schweizer, J. (Univ. of Dayton, Ohio). Appl. Phys. Lett.; 21: No. 9, 446-8(1 Nov 1972).

The coercive forces of micron-sized $NdCo_5$ and $DiCo_5$ (Di = a Nd–Pr mixture) are less than 200 Oe. When these compounds were sintered with Pr–Co and Sm–Co as sintering aids, relatively high coercivities could be obtained. The highest coercivities of sintered $NdCo_5$ and $DiCo_5$ are 4000 and 10,280 Oe, respectively. (auth)

1892 ENHANCEMENT OF ANNIHILATION RATE OF ELECTRON–POSITRON PAIRS IN PERIODIC FIELDS. Fujiwara, Kunio; Hyodo, Toshio; Ohyama, Jun-ichi (Tokyo Univ.). J. Phys. Soc. Jap.; 33: No. 4, 1047-59(Oct 1972).

The enhancement of the partial annihilation rate of electron–positron pairs in crystals was examined by assuming a two-band structure of electrons and using the lowest-order ladder graphs with static interaction. The intraband transitions of electrons due to the attractive force of positrons cause the enhancement of the rate over all the components of the momentum, while the interband transitions from the lower to the upper give a marked dehancement of higher-momentum components (HMC's) despite the fact that the total annihilation rate remains still enhanced. Numerical computation was made for several one-dimensional cases, and an asymmetry with respect to the zone face was found even in the enhancement due to intraband transitions. An angular-correlation measurement was made for silicon, and evidence for the dehancement of HMC's was found by comparing the data with the independent-particle theory of Stroud and Ehrenreich (Phys. Rev., 171: 399 (1968)). (auth)

1893 PARAMAGNETIC BEHAVIOR IN NONSTOICHIOMETRIC COMPOSITION OF THE LAVES-PHASE COMPOUND IN THE Zr–Co ALLOY SYSTEM. Aoki, Y.; Nakamichi, T.; Yamamoto, M. (Tohoku Univ., Sendai). Phys. Status Solidi (b); 53: No. 2, K137-9(1 Oct 1972).

Magnetic susceptibility was measured at 4.2 to 300°K for compositions of 28.3 to 33.7 at.% Zr. The 33.1 and 33.7 at.% Zr alloys seem to be nonmagnetic, while the susceptibility of the cobalt-richer alloys increases at lower temperatures, suggesting localized moments. These Co-rich alloys follow the modified Curie–Weiss law $\chi_0 + C(T - \theta)$. The magnetic moment per excess Co atom is found to be 1.3 μ_B. (D.L.C.)

1894 APPLICATION OF THE QUANTUM THEORY OF DIFFUSION TO H AND D IN NIOBIUM. Sussmann, J. A.; Weissman, Y. (Soreq Nuclear Research Centre, Yavne, Israel). Phys. Status Solidi (b); 53: No. 2, 419-29(1 Oct 1972).

The quantum-mechanical diffusion mechanism for the case of strong coupling between lattice phonons and the migrating particle is developed. In this mechanism the particle is excited from a localized ground state to time-dependent Wannier states in several accessible bands, from where it falls down into neighboring or nonneighboring sites. This mechanism leads to a classical-like expression for the jumping probability, $W = \nu_0 e^{-E/kT}$, where E is the excitation energy to the band and ν_0 is related to the width of the band. This theory is shown to account for the experimental data on hydrogen diffusion in niobium, which exhibits two sets of activation energies and pre-exponential factors, and a highly nonclassical isotope effect. Available diffusion data in V and Ta are also found compatible with the same model. (auth)

1895 HARTREE–FOCK CALCULATION OF ELECTRON STATES IN SMALL AGGREGATES OF LITHIUM AND BERYLLIUM ATOMS. Stoll, H.; Preuss, H. (Univ., Stuttgart). Phys. Status Solidi (b); 53: No. 2, 519-25(1 Oct 1972).

SCF–MO–LCGO calculations, which have been performed on small periodic aggregates of Li and Be atoms, are reported. It is shown that properties characteristic of solids can be found readily in comparatively small systems. The variation of these properties with shape and size of the systems is discussed. In addition, effects attributed to the influence of the surface are treated, e.g., charge-density fluctuation and lattice distortion in the zone near the boundaries. (auth)

1896 ATOMIC AND MOLECULAR SCATTERING, DIFFRACTION, AND TRAPPING ON TUNGSTEN AND PLATINUM SURFACES. Weinberg, W. H.; Merrill, R. P. (Univ. of California, Berkeley). pp 151-68 of Adsorption–Desorption Phenomena. /Ricca, F. (ed.).

From second international conference on adsorption–desorption phenomena; Florence, Italy (14 Apr 1971). See CONF-710459.

It is stated that in studies of the scattering of collimated molecular and atomic beams from solid surfaces, and the scattering of light gases, careful attention must be given to the preparation of the surfaces concerned and the limitation of the contamination of the surfaces by spectra background gases. Experimental work should be performed at ultrahigh vacuum ($<10^{-10}$ torr), and if characterization of the surface (for example by low-energy electron diffraction, Auger spectroscopy, flash desorption, work function measurements, etc.) can be made in situ, the reliability of conclusions reached can be considerably enhanced. Much of the scattering data from metals previously reported had involved surfaces whose state is highly questionable. Ultrahigh vacuum systems have been constructed at Berkeley for use in this work. The purpose of the present paper is to identify, from reported scattering data, what may be some rather general modes of interaction for scattering from metals and to examine the sort of structural information that is potentially available from diffractive and nondiffractive scattering of He

and D. Scattering from three different metal surfaces is discussed: Pt(111), Pt(100), and W(110), representing regular progression of the smoothest possible surface packing, fcc (111), to the more open structure of fcc (100), with bcc (110) intermediate in atomic surface roughness. Three scattering regimes were identified—quasi-elastic, inelastic, and trapping—and these are discussed. (19 references) (UK)

1897 USE OF RADIOACTIVE TRACERS FOR STUDYING DISTRIBUTION OF MICROIMPURITIES IN THIN LAYERS. Shvedov, V. P.; Timofeev, O. A.; Solov'ev, V. B.; Ignatov, V. E. J. Appl. Chem. USSR (Engl. Transl.); 45: No. 3, 698-700(Mar 1972).

Translated from Zh. Prikl. Khim.; 45: No. 3, 686-8(Mar 1972).

A vacuum evaporation method and apparatus were developed for the analysis of the distribution of impurities (content 10^{-1} to 10^{-4}%) in thin microelectronic films. In order to characterize the method, the distribution of thallium impurity in lead oxide films was studied. $TlNO_3$ was used as the source of the TlO_2; ^{204}Tl was the radioisotope used. Results show that the Tl distribution in films evaporated in O_2 is not uniform; it is concentrated in the first layers. (D.L.C.)

1898 PHYSICAL PROPERTIES OF W–Y_2O_3 MATERIALS. Peletskii, V. E.; Druzhinin, V. P. (Inst. of High Temperatures, Moscow). Sov. Powder Met. Metal Ceram. (Engl. Transl.); 11: No. 4, 318-21(Apr 1972).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; 11: No. 4, 79-82(Apr 1972).

Studies were made on the emissivity and electric conductivity of two W–Y_2O_3 composite materials. The materials, prepared by the powder metallurgy method, had a two-phase structure. The relative error of a single electric conductivity determination did not exceed ±2.6 to 2.8%. Tests were conducted in a vacuum of ~10^{-5} mm Hg. At room temperature, the electric conductivities of two specimens were 5.94 and 6.21 $\mu\Omega$-cm, respectively. The test temperature range for emissivity measurements was 1100 to 3200°K. When the specimen was heated for the first time, high values of emissivity were recorded. After heating above 2200°C, the emissivity of the specimen became stabilized. It was also found that the emissivity of a W–2.3% Y_2O_3 cermet surface stabilized by vacuum annealing exceeded that of a W surface by about 13%; heating to 3200°K increased this difference to 32 to 35%. The possible relation between the emissivity of the cermet and its oxide phase content can be approximately assessed by making the obvious assumption that surface emission losses are additive. (P.C.H.)

Moessbauer Effects and NMR

Refer also to abstracts 405, 406, 1203, 1525, 1580, and 1619.

1899 (JUL-853-FF) NUCLEAR RESONANCE INVESTIGATION IN THE SYSTEMS NIOBIUM–HYDROGEN AND NIOBIUM–DEUTERIUM. Bohn, H. G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). May 1972. 69p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

Nuclear resonance measurements were performed on the systems niobium–hydrogen and niobium–deuterium. For niobium–hydrogen, the temperature dependence of the proton relaxation time was measured between 500 and 4°K. Behavior of relaxation is explained through diffusion-dependent dipole–dipole interaction between protons and niobium nuclei, as well as through coupling of protons on conduction electrons. By taking into consideration the electronic contribution to relaxation, the discrepancy between nuclear magnetic resonance and macroscopic diffusion measurements could be eliminated. The nuclear resonance determinations on niobium–deuterium were performed on nearly single-crystalline foils. As a consequence, position of the electric field gradient tensors could be determined with respect to the crystal axis. Results are explainable with either an octahedral or tetrahedral model. (H.B.G.)

1900 TIME-DIFFERENTIAL PERTURBED ANGULAR CORRELATION INVESTIGATION OF THE TEMPERATURE DEPENDENCE OF THE ELECTRIC QUADRUPOLE HYPERFINE INTERACTION AT THE NUCLEI OF ^{172}Yb IMPURITIES IN THULIUM METAL. Long, Anne Chuhran. Philadelphia; Univ. of Pennsylvania (1972). 137p. University Microfilms Order No. 72-25,621.

Thesis.

Measurements were carried out between 77 and 560°K. The quadrupole interaction strength is proportional to the product of the spectroscopic static quadrupole moment of the nucleus and the electric field gradient (EFG) at the nucleus. Since the nuclear quadrupole moment is known, the magnitude of the EFG can be obtained. The total EFG experienced by a rare earth nucleus in a metal lattice arises from a variety of sources: other lattice ions, conduction electrons, the unfilled 4f shell of the impurity ion and the closed inner electronic shells of the impurity ion. At 77°K, the absolute value of the largest component of EFG, V_{zz}, equals $6.15 \pm 0.05 \times 10^{17}$ V/cm^2 at the nuclei of the ^{172}Yb impurities. Above 77°K, V_{zz} was found to decrease by (0.066 ± 0.006)% for a 1°K rise in temperature. Such a linear temperature dependence is inconsistent with a contribution to the EFG from an unfilled 4f shell, which means that the ytterbium impurity ions must be doubly rather than triply ionized. Thus, the EFG results only from the ions situated at the lattice sites, antishielded by the closed electronic shells of the impurity ion, and from the conduction electrons. The magnitude of V_{zz} is about twice that expected from the lattice ions shielded by a uniform conduction electron density. Conduction electrons in nonspherically symmetric orbits in the close vicinity of the nucleus may thus produce a substantial portion of the EFG. The rate-of-change of V_{zz} with temperature is more than twice that expected from nonisotropic thermal lattice expansion. The additional temperature dependence may result from the conduction electron contribution. Comparison of the experimental result with that expected from the various possible sources of the EFG leads to definite conclusions concerning limits on the size of certain contributions. (Diss. Abstr. Int., B)

1901 COULOMB-EXCITATION MOESSBAUER EFFECT IN THE 21.6-keV STATE OF ^{151}Eu. Lambe, R. L; Schroeer, D. (Univ. of North Carolina, Chapel Hill). Phys. Lett.; 41A: No. 5, 435-6(23 Oct 1972).

The Moessbauer effect in the 21.6-keV state of ^{151}Eu was observed following Coulomb excitation with 3.3-MeV alpha particles at 85°K and at room temperature. At 85°K, line broadening and an isomer shift were found in an oxide target (Eu_2O_3). (auth)

1902 NUCLEAR MAGNETIC RESONANCE OF RARE-EARTH-METAL ALLOYS. Itoh, J. (Osaka Univ.). Bunseki Kiki; 10: No. 2, 81-7(Feb 1972). (In Japanese).

In the ions of heavy rare earth metals (Gd, Tb, Dy, Ho, Er, and Tm) the electrons in the 4f shell are insufficient, since the 4f shell is filled up with fourteen electrons. Being shielded with the electrons of the outer 5s and 5p shells, it is conceivable that the magnetic moment of each 4f ion is strongly localized at lattice points. The NMR frequency Vm is expressed as follows: Vm, m + 1 = a – b (2m + 1). For the rare metals, the a and b can be hundreds to thousands of MHz. Observation of the NMR of Dy was successful by using a spin-echo device already developed for the NMR observation in these frequency regions. Though measurement required considerable time, skill, and practice at liquid helium temperature, NMR signals for the Tb, Dy metals, and other alloys were very strong and spin–lattice and spin–spin relaxation measurements were accurately carried out. Experimental results for these two metals and for alloys of the rare earth metals are described in detail. (Japan)

1903 INFLUENCE OF ZIRCONIUM ON THE QUADRUPOLE INTERACTION OF ^{181}Ta IN METALLIC HAFNIUM. Baudry, A.; Boyer, P. (CEN, Grenoble, France). Phys. Status Solidi (b); 53: No. 2, 587-92(1 Oct 1972). (In French).

The measurement of the $\gamma-\gamma$ differential angular correlation attenuation factor $G_2(t)$ on the ^{181}Ta 133 to 482-keV cascade in a very pure polycrystalline hafnium sample and in the same material alloyed with zirconium emphasizes the influence of this impurity on the difference between the frequently observed quadrupole-interaction asymmetry parameter ($\eta \approx 0.30$) and the expected value ($\eta = 0$) for an hcp lattice. (auth)

1904 RESONANT ABSORPTION OF γ RAYS BY A DEFORMED CRYSTAL. Srivastava, B. P.; Sharma, H. N. K.; Bhattacharya, D. L. (Banaras Hindu Univ., India). Phys. Status Solidi (b); 53: No. 2, 683-91(1 Oct 1972).

The exponent of the Debye–Waller factor and the energy shift for γ rays resonantly absorbed by a deformed crystal (deformation introduced along a line) were calculated using the technique of double-time Green's function. It was found that, due to deformation, there exists an observable broadening of the Moessbauer line, and an additional energy shift also appears which, however, may not be well observed. A quadrupole splitting of the line was predicted on the basis of deformation of the lattice. (auth)

1905 NMR AND SUSCEPTIBILITIES OF $CeAl_x$ INTERMETALLIC COMPOUNDS. Niculescu, V. (Univ., Cluj); Pop, I.; Rosenberg, M. Phys. Status Solidi (b); 53: No. 2, 701-10(1 Oct 1972).

NMR and magnetic susceptibility of $CeAl_x$ intermetallic compounds with x = 1,2,3, and 4 were investigated. The most important contributions to the magnetic susceptibility are the Curie–Weiss term, expressing the paramagnetism of the localized f-electrons and the temperature-independent term due to an en-

hanced Pauli paramagnetism, the enhancement factor increasing exponentially with the cerium concentration. The temperature dependence of the observed strong positive Knight shift is explained by the enhancement of the hyperfine interaction at the ^{27}Al sites, owing to the exchange polarization of the conduction electrons by the localized cerium f-electrons. The exchange constants J_{fs} and θ_p are negative for the four compounds. A positive sign of the sum results which characterizes the oscillating behavior of the indirect exchange interaction between the rare-earth ions. (auth)

1906 MOESSBAUER INVESTIGATION OF IRON IN BORON. Waeppling, R.; Haeggstroem, L.; Devanarayanan, S. (Univ. of Uppsala). Phys. Scr.; 5: No. 1-2, 97-8(1972).

An investigation of boron samples containing ~1 at. % iron indicate that the iron atoms populate three different crystallographic positions. The isomer shifts obtained are far from the "metallic" values expected, indicating large rearrangements of electrons around the iron nuclei. (auth) (Sweden)

Theory

Refer also to abstract 1660.

1907 (COO-2103-19) NONMUFFIN TIN VARIATIONS OF POTENTIALS IN METALS. Waber, J. T. (Northwestern Univ., Evanston, Ill. Dept. of Materials Science. Los Alamos Scientific Lab., N. Mex.); Koelling, D. D. (Northwestern Univ., Evanston, Ill. Dept. of Physics. Argonne National Lab., Ill.). 1972. Contract AT(11-1)-2103. 42p. Dep. NTIS.

The various prescriptions for constructing the muffin-tin approximation to a crystal potential are reviewed and compared. The corrections to this approximate form of the crystal potential are discussed. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 1202, 1446, and 1912.

1908 (AECL–4152) NUMERICAL SOLUTION OF A NON-LINEAR DIFFUSION EQUATION. Selander, W. N. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 19p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

A numerical method is derived for computing the similarity solution of the diffusion equation in a semi-infinite region when the diffusion coefficient is a linear function of the quantity undergoing diffusion. The solutions may be represented in terms of a one-parameter family of curves and a number of cases, covering a wide range of values of the parameter, are given graphically. The program for computing the solutions is described and an error analysis is given. (auth)

1909 RIGOROUS METHOD FOR SOLVING NONLINEAR EQUATIONS: HARTREE–FOCK AND RELATED PROBLEMS. Catara, F.; Di Toro, M.; Pace, E.; Schiffrer, G. (Univ., Catania, Italy). Nuovo Cim.; 11A: No. 3, 733-48(1 Oct 1972).

A rigorous iteration method for the solution of nonlinear equations in Banach spaces, due to Isaac Newton and Kantorovich, is reported. Its application to three nonlinear problems of atomic and nuclear physics in finite-dimensional spaces is considered: the ordinary, the constrained, and a generalized Hartree–Fock problem. The existence of a solution of the Hartree–Fock equations and its uniqueness in a definite small region of the functional space are proved for the nucleus ^{16}O. This method converges faster than the usual Hartree algorithm and displays some further advantages. (2 tables) (auth)

1910 PRINCIPLES OF ANALYTIC APPROXIMATION THEORY AS APPLIED TO ANALYSIS OF EXPERIMENTAL DATA. Cutkosky, R. E. (Carnegie-Mellon Univ., Pittsburgh). Lect. Theor. Phys.; 14A: 423-53(1972).

A review is given of the polynomial approximation theory; the point is illustrated that the convergence properties of a sequence of approximating functions depend jointly on the data used and on analyticity. It is then shown how to use a conformal transformation to obtain the most rapidly convergent polynomial approximation for representation of physical data. Further mathematical tools are presented; the fundamental mathematical tool is the Hilbert space of analytic functions. In addition, the ideas of generalized interpolation and of a probability measure in the function space are presented. An exposition of the application of the mathematical theory to a reformation of the conventional χ^2-minimization technique for fitting experimental data is given. It is shown how to construct the best sequence of functions for a linear representation of experimental data, and a convergence test function is constructed which can be used to solve the problem of estimating the truncation point and truncation error of the expansion. (L.B.S.)

1911 CONSTRUCTION OF OSCILLATORY BASIS FUNCTIONS FOR FOUR-PARTICLE SYSTEMS. Macharadze, T. S.; Bartaya, O. L. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 68: No. 1, 45-8(Oct 1972). (In Russian).

A new technique for the construction of oscillatory basis functions is given. Orbital basis functions are constructed for four-particle systems. A recurrent relation is obtained for symmetrizing coefficients entering these functions. (auth)

1912 SOME ALGEBRAIC ASPECTS OF THE RELATIONSHIP BETWEEN CLASSICAL AND QUANTUM MECHANICS. Sahoo, Debendranath. New York; Yeshiva Univ. (1972). 68p. University Microfilms Order No. 72-23,583.

Thesis.

An explicit relation between the algebraic structures of classical and quantum mechanics was established. This structural relation is shown to provide the abstract basis for the possibility of representing quantum mechanics and classical mechanics in the same space. Furthermore, the structural relation is shown to be a useful tool for investigating problems related to canonical quantization. (Diss. Abstr. Int., B)

1913 LOCAL OBSERVABLES IN THE PAULI AND DIRAC FORMULATIONS OF QUANTUM THEORY. Gurtler, Richard Warren. Tempe, Ariz.; Arizona State Univ. (1972). 178p. University Microfilms Order No. 72-23,162.

Thesis.

Quantum theory in the Pauli and Dirac versions is expressed in terms of a set of hydrodynamic-like equations of motion for a set of "local observables" which arise naturally in the theory. This description is carried out entirely in terms of the real, multivector algebra and results in a much more coherent presentation than the usual complex matrices approach. The set of observables used in the Pauli theory differs from the usual descriptions in its use of a velocity $\underset{\sim}{v}$, whose definition does not coincide with that of conventional theory. By analysis of the Pauli limit of the Dirac theory it is shown that this $\underset{\sim}{v}$ is "correctly" defined in the sense that it agrees with the Dirac theory. Analysis of the set of hydrodynamic equations obtained also indicates some interesting conclusions relating to the effects of external fields on the "intrinsic" magnetic moment of the electron. The parameter β which arises in the Dirac theory is separated out and so indicated in the Pauli theory. Analysis of the nonrelativistic limit of the Dirac theory brings out conditions on the size of β which relates to the interpretation of this observable. The hydrogen atom is treated extensively to study the behavior of the local observables for these exact solutions of the relativistic and nonrelativistic regimes. The properties of the velocity and the parameter β are studied. A new angular momentum $\underset{\sim}{L}^*$ is defined and is shown to correspond closely to the angular momentum of the Bohr-Sommerfeld theory. Expectation values of all pertinent observables are calculated when possible, yielding several new results. Finally, a virial theorem is studied for the hydrogen atom and it is seen that use of $\underset{\sim}{v}$ results in a simple expression which closely parallels the classical result. A Lagrangian formulation of the Dirac theory is presented which utilizes the multivector algebra framework. (Diss. Abstr. Int., B)

1914 KRAMERS–KRONIG RELATIONS AND SUM RULES. Kubo, Ryogo (State Univ. of New York, Stony Brook); Ichimura, Munetake. J. Math. Phys.; 13: No. 10, 1454-61(Oct 1972).

The concept of moments, which are integrals of positive or negative integral powers ω^n weighted by real or imaginary parts of admittance functions, is generalized so as to be applied to a wide category of admittance functions, including Lorentzian functions. The generalized moments are related to the derivatives or integrals of sum rules in a general sense. This analysis is based on differentiation and integration–mapping of admittance functions and the associated Kramers–Kronig relations. Some model calculations are also shown. (auth)

1915 METHOD FOR RAPID NUMERICAL SOLUTION OF THE ONE-DIMENSIONAL SCHROEDINGER EQUATION. Newman, William I. (Univ. of Alberta, Edmonton); Thorson, Walter R. Phys. Rev. Lett.; 29: No. 19, 1350-3(6 Nov 1972).

One can generate certain special solutions to the one-dimensional Schrödinger equation, $\exp[\pm iS_\pm(x)]$, such that $S_\pm(x)$ and derivatives are computationally unique, slowly varying, and do not have oscillatory or steplike behavior associated with the de Broglie wavelength. This leads to a method for accurate numerical solution which has all the advantages of high computational speed and conceptual simplicity of the JWKB approximation—of which it is the extension to an exact solution. (auth)

1916 ZITTERBEWEGUNG AS A SUBDYNAMICS. Rae, J. (Univ., Brussels). J. Phys., A (London); 5: No. 10, 1438-46 (Oct 1972).

The superoperator theory of nonequilibrium statistical mechanics is applied to the Dirac and Klein–Gordon equations. The transformation operators of this theory are found to be closely related to the Foldy–Wouthuysen transformation while the associated subdynamics corresponds to the separation into smooth motion and zitterbewegung. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstract 2178.

1917 NUCLEAR POWER REACTORS AS AN ENERGY SOURCE. Carbon, P.; Hicken, E. Tech. Zukunft; No. 3, 110-13(1971). (In German).
A general survey is given on the present status as well as on future trends in power reactor development. (INIS)

1918 ADVANCED HWR POWER PLANTS. Lewis, W. Bennett (Chalk River Nuclear Labs., Ont.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 1(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1919 LOOKING AHEAD AT THE PWR. West, J. M.; Abbott, W. E.; Dietrich, J. R. (Combustion Engineering Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 1-2(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1920 PWR IN THE 1980's. Arnold, W. H.; Retallick, F. D.; Braun, H. E. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 2(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1921 BWR DESIGN FOR IMPROVED PERFORMANCE. Hinds, John; Sanni, P.; Wade, G. E.; Fuller, E. D. (General Electric Co., San Jose, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 3(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1922 COMMERCIAL HTGR POWER PLANTS. Waage, J. M. (Gulf General Atomic, San Diego, Calif.). Trans. Amer Nucl. Soc.; 15: Suppl. No. 2, 6(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1923 STATUS AND FUTURE TRENDS OF HTR DEVELOPMENT IN THE FEDERAL REPUBLIC OF GERMANY. Kraemer, H.; Bergmann, B. (Kernforschungsanlage, Juelich, Ger.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 7(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1924 EUROPEAN GCFR PROGRAM PLANS. Dalle Donne, M.; Wirtz, K. (Kernforschungszentrum, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 7-8(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1925 GAS-COOLED FAST BREEDER REACTOR PROGRAM IN THE US. Simon, Robert H. (Gulf General Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 8-9(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1926 STATUS OF US FAST REACTOR OPERATIONS. Lawroski, H. (Argonne National Lab., Idaho Falls, Idaho); Alexanderson, E. L.; Shoudy, A. A.; Arterburn, J. O.; Greebler, P. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 10(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1927 RAPSODIE EXPERIENCE: PHENIX CONSTRUCTION AND PREOPERATIONAL EXPERIENCE. Chantot, H. (CEN de Cadarache, Saint-Paul-Lez-Durance, France); Megy, J. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 11-12(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1928 FAST BREEDER REACTOR DEVELOPMENT IN THE USSR. Kintner, Edwin E. (Atomic Energy Commission, Washington, D. C.); Taylor, J. J. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 12-13(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1929 STATUS OF PFR CONSTRUCTION. Campbell, R. H.; Laithwaite, J. M. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 13(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1930 FRENCH LARGE LMFBR DESIGN. Denielou, G. (CEN de Cadarache, Saint-Paul-Lez-Durance, France); Carle, R. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 14(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1931 STATUS OF THE SNR PROJECT AND FUTURE PLANS FOR LMFBR DEVELOPMENT. Guthmann, Elmar A. (Interatom, Bensberg, Ger.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 14-15(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1932 LMFBR DEVELOPMENT IN JAPAN. Oyama, A.; Suzuki, Y.; Kawashima, K. (Power Reactor Nuclear Fuel Development Corp., Tokyo). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 15-16(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1933 US LMFBR DEMONSTRATION PLANT TODAY. Van Nort, Peter S. (Project Management Corp., Chicago). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 16(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1934 DEVELOPMENT OF THE COMMERCIAL BREEDERS. Wolfe, B.; Barnard, J.; Fidrych, L. F.; Horst, K. M.; Murphy, P. M. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 16(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1935 KEYS TO OPEN THE DOOR OF INDUSTRIAL SUCCESS OF THE LMFBR. Taylor, J. J.; Petrick, N. A. (Westinghouse Electric Corp., Pittsburgh). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 16-17(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1936 LMFBR DEMONSTRATION PLANT PROGRAM. Balent, R. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 17-18(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1937 LONG-RANGE CONSIDERATIONS IN THE DEVELOPMENT OF HIGHER PERFORMANCE LMFBRs. Noyes, R. C. (Combustion Engineering Inc., Windsor, Conn.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 18-19(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1938 PRESENT STATUS AND FUTURE PROSPECTS OF MOLTEN SALT REACTOR SYSTEMS. de-Boisblanc, D. R. (Ebasco Services, Inc., New York). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 20-1(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1939 POTENTIAL OF NUCLEAR-MHD: CLEAN, CHEAP, ABUNDANT POWER. Williams, J. R. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 26-7 (1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1940 HYDROGEN PRODUCTION FOR BETTER NUCLEAR UTILIZATION. Thornton, Robert M. (Georgia Inst. of Tech., Atlanta). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 27-8(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1941 MHD POWER GENERATION. Rosa, Richard J. (Avco Everett Research Lab., Everett, Mass.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 28(1972).
From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1942 GAS-COOLED HIGH-TEMPERATURE REACTORS. Bedenig, D. Thiemig-Taschenbuecher, Volume 44. Munich; Gasgekuehlte Hochtemperaturreaktoren (1972). 245p. (In German).
The most important physical and technical aspects of the HTGR are dealt with namely: primary circuit; auxiliary systems and

secondary installations, fuels and fuel elements, fuel charging and discharging equipment, physics of the high-temperature reactor safety and control, existing reactors–present state of the HTR development, planned reactors–future development. (Germany)

1943 DEVELOPMENT OF FAST REACTORS. I. Rockstroh, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 15: No. 3, 73-7(Mar 1972). (In German).

A general review is given of objectives, status, and problems to be solved in development of fast breeder reactors. (auth)

1944 BOILING WATER REACTOR DEVELOPMENT AND ITS MECHANICAL-STRUCTURAL REQUIREMENTS AND PROBLEMS. Traube, K. (AEG Telefunken, Frankfurt am Main). Nucl. Eng. Des.; 19: No. 1, 55-69(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

A brief review of the state of development of boiling water reactors is given, pointing out differences in the boiling water reactor technology of GE and AEG. Design problems of large components of the boiling water reactor primary circuit are outlined and the safety of steel reactor pressure vessels is discussed giving special consideration to problems of stress analysis and fracture mechanics. The characteristics of the design of concrete structures considering extreme accident conditions are described. Finally, mechanical problems of the BWR fuel element cannings are briefly discussed. (auth)

1945 HIGH-TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT AND ITS MECHANICAL-STRUCTURAL REQUIREMENTS AND PROBLEMS. von der Decken, C. B.; Schulten, R. (Kernforschungsanlage, Juelich, Ger.). Nucl. Eng. Des.; 19: No. 1, 71-84(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The development and current status of high-temperature reactors are presented. Future development potentialities and possible trends are discussed. In addition to the application of high-temperature reactors for electricity generation the important question of direct utilization of nuclear heat is raised. A short survey of the structure-mechanical problems of high-temperature reactors is given. (auth)

1946 LIQUID METAL COOLED FAST BREEDER REACTOR DEVELOPMENT AND ITS MECHANICAL-STRUCTURAL REQUIREMENTS AND PROBLEMS. Mueller, R. A.; Smidt, D. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Des.; 19: No. 1, 85-98(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

After a brief survey about the history and the present status of liquid metal cooled fast reactors the specific properties of liquid sodium and the principal layout of sodium-cooled fast reactor plants are explained. The most important mechanical-structural requirements and problems are broken down into fields of sodium containment, core structure, and special mechanisms to be operated in sodium and the cover gas atmosphere. With respect to sodium containment, the main difficulties raised concern mechanical and thermal cycling stresses during transient operational conditions and creep effects appearing in the walls which are subjected to high temperatures. The requirements for the core structure have become extremely complicated due to swelling of the structural material at high neutron doses. In the field of mechanics special attention must be given to all questions of material pairing with respect to diffusion welding, friction and wear. (auth)

1947 DEVELOPMENT OF ASEISMIC DESIGN OF PIPING, VESSELS, AND EQUIPMENT IN NUCLEAR FACILITIES. Shibata, Heki (Tokyo Univ.); Watari, Atsushi; Sato, Hisayoshi; (and others). Nucl. Eng. Des.; 20: No. 2, 393-427(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

The development of aseismic design procedures of piping, vessels and equipment in Japan is described. These mechanical structures show their various characteristics of vibration. Pressure boundaries, a containment vessel and safety systems belong to such structures. The vital components of nuclear power plants are classified to "A" class according to the classification for the aseismic design in Japan. All components in "A" class are required to be based on dynamic earthquake-resistant design, of which level is decided in consideration of local seismisity. For dynamic design purposes, the following processes are the most important: (1) estimating eigenfrequencies and modes of the system; (2) estimating its damping characteristics; (3) estimating the behavior of the system during strong earthquakes; and (4) deciding the design criteria, especially the allowable stresses to earthquake loadings. (auth)

Physics and Core Engineering

1948 (ANL–7910, pp 31-336) FAST REACTOR PHYSICS. Jan 1972.

In Applied Physics Division annual report, July 1, 1970 to June 30, 1971.

The analyses and measurements of liquid metal fast breeder reactor characteristics and parameters are discussed. The measurements are generally made on the critical facilities ZPPR (Zero Power Plutonium Reactor), ZPR-3, ZPR-6 and ZPR-9, and are often performed to check calculated results and hence to evaluate the analytical methods and the nuclear constants used in the calculations. (auth)

1949 (GEAP–13761) DESIGN, DEVELOPMENT, AND TESTING OF THE SEFOR REACTIVITY OSCILLATOR SYSTEM. Margetanski, W. J.; McKeehan, E. R. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Jun 1972. Contract AT(04-3)-540. 46p. Dep. NTIS.

The Reactivity Oscillator was designed to provide a controlled system for oscillating reactivity with variable frequency and amplitude. To accomplish this, a mechanism, which incorporated a d-c motor driven scotch-yoke device, was designed and extensively tested. The mechanism has demonstrated reliable and reproducible performance over the complete range of frequencies and amplitudes required. The oscillator drive uses a scotch-yoke device to provide sine wave oscillations of a poison rod about a pre-set core axial position, thus introducing oscillating increments of reactivity into the core. The oscillator mechanism is supported on the reactor vessel head at the center position by the positioner and drywell. A d-c motor with a 30 to 1 speed range drives the scotch-yoke mechanism through a gear reducer which provides an additional 20 to 1 step speed change. The poison rod, being attached to the cam of the scotch yoke mechanism, is oscillated up and down in a sine wave motion. Amplitude is variable through adjustment of a lead screw on the rotor mechanism. A Balanced Oscillator Control System was also developed which provides oscillating control signals to the main primary and main secondary coolant pumps as required to achieve balanced conditions with the oscillating reactivity. (6 references) (auth)

1950 (JAERI-Memo–4036) STUDY OF FAST NEUTRON SPECTRUM WITH NUCLEAR EMULSION. (Japan Atomic Energy Research Inst., Tokyo). May 1970. (In Japanese). NTIS (U. S. Sales Only).

In fast reactor analysis, it is important to measure accurately the space-dependent neutron spectrum in the reactor core. A new generalized analysis method is proposed for measuring the angular neutron fluxes at arbitrary positions in the core. This method is based on measuring the difference in the distribution of recoil proton tracks between the two directions at right angle in an emulsion. To analyze the heterogeneity effect in a fast reactor core with cell plate-arrangement, a simple method is also proposed for measuring the fine structure of neutron fluxes. Further, the results of analysis are given on the anisotropy of neutron fluxes in a fast reactor core with cell arrangement and on the diffusion coefficient for neutrons leaking from the reactor core. Finally, their applications to the reactor analysis, in the above connection, are described. (auth)

1951 (RISO–270) APPROXIMATE METHODS FOR 3D OVERALL CALCULATIONS ON LIGHT WATER REACTORS. Larsen, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 48p. Dep. NTIS (U. S. Sales Only).

Thesis.

The applicability of the different approximate methods used for the solution of the three-dimensional diffusion equation is discussed. The flux synthesis program SYNTRON has been coupled with hydraulics and quasi-stationary burnup treatment to be used for boiling water reactor calculations. Test calculations are presented. 25 references. (auth)

Control Elements, Systems, and Instrumentation

1952 (STI/PUB–301) NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION. Panel Proceedings Series. Proceedings of a Working Group Meeting Held in Vienna, 15–19 March 1971. (International Atomic Energy Agency, Vienna

(Austria)). Apr 1972. 317p. (In several languages). (CONF-710340). IAEA $10.00.

Included are 26 papers on the experience acquired and actual problems encountered in the field of power reactor control and instrumentation. Emphasis is placed on the technical, industrial, and economic aspects of the subject. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 1954–1973, 2022–2027.

1953 PROBLEMS OF DIGITAL CONTROL OF NUCLEAR POWER PLANTS. Ciechanowicz, W. (Institut fuer Kernforschung, Warsaw). Kernenergie; 15: No. 2, 53-6(Feb 1972). (In German).

Work in the field of digital control of nuclear power plants is discussed. The first discussion involves the formulation of the transient digital control problem of power reactors. Simplifications have been considered that have to be made to enable modern control theory to be applicable for use in digital control. Included in the discussion are the approaches of digital control systems that would satisfy stability, autonomy, and optimal filtering criteria. The aim of this discussion is to propose possible solutions of the considered problem and further investigations. The scope of the second discussion was to check theoretically the compromise in the control-strategy design to decrease the required number of computations. Two types of HBWR control system models have been investigated: one involves the control-strategy calculation for the overall dynamic system; in the other case, the overall system has been split into two systems characterized by smaller number of state variables. The interactions between the split systems have been included by use of cross-coupling controller elements. The comparison between considered control models has shown similar dynamic behavior of the investigated state values. The main advantage of splitting the system is decreasing the order of state vectors taken into account in the control-strategy calculations. The scope of the third discussion was the further investigation of the control-strategy problem. The digital control system of a model of a nuclear BWR power plant of 500 MW(e) output was considered. 19 references. (auth)

1954 STATUS OF POWER REACTOR CONTROL AND INSTRUMENTATION IN THE USA. Moore, V. A. Jr.; Hanauer, S. H. (Atomic Energy Commission, Washington, D. C.). pp 1-29 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The experience and progress since November 1969 and the status of US power reactor control and instrumentation are discussed. After major effort in the development and implementation of codes, standards and criteria and, due to the industry expansion, new US and international standards were developed, particularly with regard to safety. Some of the criteria issued by the USAEC and that require interpretation are discussed. The following topics are included: (1) The US consideration of reliability analysis with regard to the systems that trip the reactor, together with those that initiate engineered safety feature action to mitigate the effects of reactor accidents; more concern is given to the study of common mode failures and reliability goals. (2) The use of on-line computers as data loggers and annunciators in nuclear plants and in fossil plants; some principles and guidelines have emerged in applying computers and are mentioned. (3) Noise analysis; although the principles of noise analysis have been known for some years, application to power reactors has not proceeded. A program, based on empiricisms and measurements rather than on theory and technology, is therefore proposed in the hope that a useful core diagnosis tool will result. 26 references. (auth)

1955 CURRENT STATE OF WORK AND ACTIVITIES OF NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION IN JAPAN. Hara, M. (Japan Atomic Energy Research Inst., Tokai). pp 31-42 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

In Japan light-water power reactors have come increasingly into operation, and the development of fast breeder reactors has been promoted. In this connection, the objects of developmental effort in control and instrumentation have been changed from research reactors to power reactor plants. Above all the development of fast reactor instrumentation—for example, a neutron detector for high-temperature operation, wide-range neutron instrumentation for high γ-ray levels, a sodium flowmeter for individual subassemblies, etc.—has made remarkable progress. In on-line computer applications, a reactivity estimation using an optimum filter and noise analysis techniques have been studied, while performance-monitoring systems of light-water reactors have begun to produce practical data. On the other hand, improvements in the reliability of nuclear instrumentation have also been studied. The current state and the field of further development are described. 18 references. (auth)

1956 CONTROL AND INSTRUMENTATION ON CANADIAN NUCLEAR POWER PLANTS. Pearson, A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 43-62 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Four areas of control and instrumentation are reviewed: (1) the dual computer approach to control system reliability; (2) current safety system philosophy; (3) experience with pseudo-random binary sequences for determining control system characteristics; and (4) the use of self-powered in-core flux detectors in control and safety systems. (auth)

1957 REVIEW OF ACTIVITIES IN NORWAY RELATED TO CONTROL AND INSTRUMENTATION OF NUCLEAR POWER PLANTS. Lunde, J. E. (Inst. for Atomic Energy, Kjeller, Norway). pp 63-7 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Development work intended to improve the control and instrumentation of nuclear power plants is being actively pursued in Norway, primarily within the Institutt for Atomenergi. The international research program in this field conducted within the OECD Halden Reactor Project forms an integral part of the work of the Institute. The development work on control and instrumentation is based on significant research within reactor physics and dynamics, primarily for boiling water systems, and in the field of in-core instrumentation. The range of in-core instruments developed comprises systems for measuring power distribution channel hydraulics and fuel behavior. On this basis, along with the possibility of practical demonstration in the Halden Reactor, the Institute has put heavy emphasis since 1967 on the development of modern methods for reactor control and supervision using the implementation possibilities offered by relatively large on-line process control computers. To improve the reliability and flexibility of digital nuclear control systems further, work has been initiated on the application of modular, interconnected "small" computer systems. In the event of computer component failure these will reassign the functional tasks between the various computer modules according to their functional importance. Such modular systems also offer better possibilities for adaptation of multilevel control strategies. Improved computer-based operator-process communication for nuclear plants is pursued through application of advanced consoles and color displays. "Dynamic" solid-state self-checking safety systems have also been developed. The Institute considers the application of advanced control and instrumentation techniques an important means of improving the reliability and economy of nuclear power plants and thus attaches weight to further development work in this area. 19 references. (auth)

1958 AUTOMATION OF NUCLEAR REACTORS AND POWER STATIONS IN THE USSR. Kuvshinnikov, B. A. (State Committee on Utilization of Atomic Energy, Moscow). pp 69-87 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In Russian).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The general principles followed in the USSR in the automation of nuclear power stations using reactors of various types are reviewed. Specific examples of control systems used in nuclear power stations with water-water reactors, pressure-vessel boiling water reactors and channel-type boiling water reactors intended for different purposes are described. A set of standard functional units used in systems for automatic regulation, control and protection in reactor plants not intended for the production of heat are discussed. 9 references. (auth)

1959 ACTIVITIES IN NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION IN THE FEDERAL REPUBLIC OF GERMANY. Bastl, W. (Laboratorium fuer Reaktorregelung und Anlagensicherung, Garching, Ger.). pp 89-92 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Neutron flux measurement techniques based on the Campbell method have proved to be advantageous in field measurements. Several types of n, β-detectors have been investigated in power reactors. The results gained so far prove the general applicability of the detectors, but the long-time behavior still needs more investigation. The vanadium-aeroball system has undergone further development regarding the geometrical arrangement. Tests have been made on the mechanical behavior of the balls and the sensitivity of measurement. Some results of neutron flux measurements are reported. The state of development on pressure, temperature and flow measurements in sodium loops is discussed briefly. The trend to transferring more and more control tasks to the process computer continues. The concept of using three small computers for verifying a safety system is being developed. The computers are strictly separated. The advantages of the system are to be seen in its flexibility, fail-safe operation and self-detection of faults. The main features of the "control rod computer" are described. Finally a short section is given on the main task of the process computer installed in the Gundremmingen power station. (auth)

1960 STATUS REPORT ON INSTRUMENTATION, CONTROL, AND OPERATING EXPERIENCE OF NUCLEAR REACTORS IN SPAIN. De Carlos, J. E.; Tanarro, A. (Junta de Energia Nuclear, Madrid). pp 93-7 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The first nuclear power plant at Zorita, a 160-MW(e) PWR, has provided less than two years' working experience, while the 460-MW(e) BWR plant of Garoña will be in operation before the end of 1971. Vandellós, a 480-MW(e) gas cooled, natural uranium-graphite power reactor, is scheduled to produce power at the end of 1972. All these power plants have been contracted by privately owned companies on a turnkey basis. Some particular aspects of the control and operation experience of the Zorita plant are described. Besides the two experimental Argonaut-type reactors constructed by JEN, a modern fast research reactor, CORAL, has been designed and built. This has been operating since 1969 with a major contribution of its own techniques. Certain aspects affecting safety, reliable operation and self-testing are described. (auth)

1961 CURRENT STATE OF NUCLEAR POWER PLANT CONTROL ACTIVITY IN THE UNITED KINGDOM. Butterfield, M. H. (Atomic Energy Establishment, Winfrith, Eng.). pp 99-103 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The basic control concepts used on the Dounreay Prototype Fast Reactor and major features of its highly developed computer control and display system are described. Control aspects of commercial versions of this type of reactor are also discussed. Recent developments in SGHWR control, designed to make best use of its inherent dynamic capabilities for load following, are discussed. Gas cooled reactors now form a substantial part of the British grid system, have been a means of significant development in use of computers, and are the subject for interesting developments, for example, in the spatial control of the power distribution in the core. 8 references. (auth)

1962 SUMMARY OF ITALY'S ACTIVITIES AND EXPERIENCE IN THE FIELD OF NUCLEAR REACTOR CONTROL AND INSTRUMENTATION. Barabaschi, S. (CNEN, Rome). pp 105-16 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Information on the activity and experience of instrumentation and control equipment for nuclear reactors gained in Italy in the last few years mainly by CNEN and ENEL is summarized. Nuclear instrumentation and equipment with high reliability and fail-safe characteristics, experience and trends with on-line computers, dynamics measurement and noise analysis techniques, and measurement of in-core data for control and protection are discussed. (auth)

1963 REACTOR CONTROL AND REGULATION INSTRUMENTATION FOR NUCLEAR POWER PLANTS: EXPERIENCE, DEVELOPMENT, AND CONSIDERATION. Furet, J. (CEN, Saclay, France); Grangetas, J. pp 117-26 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In French).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

A brief account of the research and development program, taking into account the new choice concerning reactor lines for nuclear power plants in France is given, and recent results in research and development are described. Comments and considerations — especially those inspired by operating experience — which should influence the subsequent course of the research and development program relating to control instrumentation for nuclear power plants are examined. (auth)

1964 BRIEF REVIEW OF ACTIVITIES IN NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION IN STUDSVIK. Blomberg, P. E. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 127-9 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

1965 NUCLEAR REACTOR INSTRUMENTATION IN BRAZIL. Mundim, S. G. (Brazilian Nuclear Energy Commission, Rio de Janeiro). pp 131-4 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Activities in Brazil in the field of nuclear instrumentation at the Brazilian Nuclear Energy Commission, at the University and in industry are described. The main obstacles encountered and the development of power reactor instrumentation in the country are discussed. (auth)

1966 STATUS REPORT ON REACTOR CONTROL AND INSTRUMENTATION IN HUNGARY. Zobor, E. (Central Research Inst. for Physics, Budapest). pp 135-40 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Hungarian research into the control and instrumentation of nuclear reactors is concentrated in the Central Research Institute for Physics, Budapest. Recently obtained results and the current activities with particular emphasis on the plans for some years to come are discussed. Fully transistorized high quality linear and logarithmic pulse and d.c. channels are now available in standard modular form. Correlator plug-ins have also been developed for the multichannel analyzers manufactured in the Institute for on-line auto- and cross-correlation measurements. The safety and interlock systems for the first critical assemblies were based on relay circuitry. The system development work has led to semiconductor self-checking safety systems which, in spite of the greater complexity and the more circuit elements applied, ensure a higher reliability of reactor protection. This work was followed with theoretical investigations. The practice in the design of conventional instrumentation and safety systems in the Reactor Department, and the multichannel analyzer and computer development work in the Electronics Department were the direct background to the decision to concentrate reactor control system research around studying the application of computers to reactor control. As a first step in this field the installation of a medium-size hybrid computer is in progress and the possibility of implementing a computer control system on the WWR-SM research reactor is being studied. 15 references. (auth)

1967 RECENT DEVELOPMENTS IN NUCLEAR POWER PLANT CONTROL AND INSTRUMENTATION CARRIED OUT OR SPONSORED BY EURATOM. Colling, A. (EURATOM, Brussels). pp 141-53 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

EURATOM research programs over the last years have not included specific action in the field of nuclear power plant control and instrumentation. However, within the frame of the programs on heavy and light water moderated reactors, certain development work has been undertaken that is also of interest to nuclear power plant control: a statistical dynamics analyzer, processing periodic, transient and random signals, and computing auto- and cross-correlation functions, auto- and cross-power spectra, Fourier transforms etc., has been developed. It has been installed at the Essor test reactor at the EURATOM Joint Research Center at Ispra. Under a research contract the Italian national utility ENEL developed in its Garigliano and Trino nuclear power plants equipment that uses Ge(Li) detectors to measure the power and burn-up

distribution of irradiated fuel, including plutonium recycle fuel. Under EURATOM sponsorship ENEL is also developing an in-service monitoring system of core structures of reactor internals based on neutron noise measurement. The on-line computer of the Trino nuclear power plant has been programmed to perform calculations of the neutron noise power spectral density, compare the results to a reference spectrum and thus provide continuous long-term monitoring and incipient failure detection of core structures and reactor internals. (auth)

1968 CONTRIBUTION OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION TO THE STANDARDIZATION OF INSTRUMENTATION AND OF THE CONTROL AND REGULATION ASSEMBLIES OF NUCLEAR REACTORS. Furet, J. (CEN, Saclay, France). pp 155-60 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In French).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

After a brief historical account of the International Electrotechnical Commission (IEC), the importance of design standards and test specifications in the development of nuclear power plants is discussed. Technical Committee 45 (IEC) on Nuclear Instrumentation was established in 1960. The activities carried or planned within the framework of this Committee by Sub-Committee 45A are listed. The organization of the work that has been undertaken on international standardization is described and some comments are made on the difficulties encountered. (auth)

1969 SUPERVISION AND CONTROL OF THE HALDEN BOILING WATER REACTOR BY PROCESS COMPUTERS. Grumbach, R. (OECD Halden Reactor Project, Norway). pp 161-78 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

An international research and development program is being conducted at the OECD Halden Reactor Project on the use of process computers in the supervision and control of nuclear power plants. The program comprises the evaluation of suitable methods, their implementation on the available on-line computers, and workability demonstrations in experiments and under routine operation. The computer system has been used for on-line applications since 1968. Its hardware configuration includes 2 process computers with about 750 analog inputs and 300 digital inputs and outputs, displays and operator console. An extensive software system has been established for carrying out a multitude of functions and for providing a basis for efficient operator–process communication. Except for feedback control functions, the tasks have been executed as a part of the routine plant operation. A major effort has been made to develop and adapt concepts for the direct digital control of the reactor power, the vessel pressure and the power distribution in the core. Algorithms based on the principles of modern control theory have been worked out and their usability tested in reactor experiments. Both stationary and load-follow operation of the plant and core are considered in the control development program. The present research and development program aims at adapting the techniques tested at the Halden Project to the requirements of large nuclear power stations. 16 references. (auth)

1970 ADAPTATION OF NUCLEAR INSTRUMENTATION TO CONTROL BY MEANS OF A DIGITAL COMPUTER. Douet, P. (CEN, Saclay, France). pp 229-43 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In French).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Studies on the adaptation of nuclear instrumentation to control by means of a digital computer are discussed in two parts. The first part describes the simulation, on a hybrid computer, of the neutron monitoring system of a nuclear reactor, the main functions of which would be performed by a digital computer. The second part describes a procedure under development for the performance of power and period measurements for the entire range of reactor dynamics by means of a set of detectors controlled by a small computer. (auth)

1971 SODIUM INSTRUMENTATION OF FAST BREEDER REACTORS. Golder, J. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 251-71 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The use of sodium as a coolant in nuclear reactors presents a number of unusual problems to the design of the instrumentation. Some of these arise from the need to maintain the integrity of the containment of the sodium, even during maintenance. The presence of oxides and other impurities in sodium can detract from its performance as a coolant and thus give rise to the necessity to provide on-line instruments to measure the concentration of these impurities. Each of the instruments concerned with the sodium coolant, designed for the Prototype Fast Reactor (PFR) being built at Dounreay, is described in some detail. For each instrument, the principle of operation is outlined together with the practical problems included in achieving the required performance under commercial plant operational conditions. (auth)

1972 WIDE-RANGE NEUTRON MEASUREMENT ASSEMBLY COMBINING PULSE- AND FLUCTUATION-TYPE INSTRUMENTS. Plaige, Y. (CEN, Saclay, France). pp 273-9 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In French).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Pulse-type instrumentation is now widely used for reactor control. Fluctuation-type instrumentation is in the stage of industrial development and will come into use in the near future. These two types of instrumentation operate with the same detectors, viz. fission chambers. It is from this point of view that wide-range instrumentation utilizing both of these basic techniques is studied. A theoretical analysis of the problem and a preliminary embodiment as well as the results of in-pile tests are presented. Even at this stage it would appear feasible in the near future to design control instrumentation capable of operating over a range of 10 decades. (auth)

1973 SAFETY REACTIVITY METER. Plaige, Y. (CEN, Saclay, France). pp 281-6 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972). (In French).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Reactivity meters are highly sensitive high-speed instruments. For this reason, they come under consideration for use in reactor safety work, and in particular with fast reactors, in order to detect cooling accidents before the thermal effects have had time to appear. Certain simplifications and advances in technology have now made possible a simple, safe and inexpensive instrument. A description of the principles, the design and characteristics of the safety reactivity meter are presented. It has been tested on a reactor and the results are very satisfactory. (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

Refer also to abstract 675.

1974 ADVANCED CONTAINMENT CONCEPT FOR BOILING WATER REACTORS. Smith, E. O.; Stippich, R. E. (Black and Veatch, Kansas City, Mo.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 25(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

Cooling Systems

Refer also to abstracts 680 and 756.

1975 (ANL-7949) LIQUID-ENTRAINMENT RATE AND DROPLET SIZE RELATIVE TO POTENTIAL FUEL-FAILURE PROPAGATION DUE TO FISSION-GAS JET IMPINGEMENT IN LMFBR SUBASSEMBLIES. Chawla, T. C. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 32p. Dep. NTIS.

The Kelvin–Helmholtz instability of the gas–liquid interface of a sonic gas jet submerged in a mass of a viscous liquid is studied in order to determine the rate of liquid entrainment as well as the droplet size resulting from tearing off the liquid from the unstable liquid surface. The determination of the size of the droplets and the rate of liquid entrained is required in formulating a correlation for the heat-transfer coefficient in the spray-cooled region of the fission-gas jet-impingement area in LMFBR subassemblies. The motion of the sonic gas jet is assumed to be

described by linearized compressible flow theory with negligible shear at the gas–liquid interface; the motion of the surrounding liquid is assumed to be described by creeping flow. These assumptions are compatible with the conditions and the configuration pertaining to fission-gas release in LMFBR subassemblies from nonvented fuel at its end of life. The linear hydrodynamic stability of the gas–liquid interface under the action of the pressure perturbations, the interfacial surface tension, and the finite liquid viscous forces is considered. For fission-gas jets with values for the ratio between radius and wavelength of the disturbance much greater than one, a short-wave approximation to the dispersion equation for the instability is obtained. Approximate solutions for the growth parameters of the wave having maximum growth rate both for the case of inviscid liquid and highly viscous liquid are obtained; the exact solution for liquids having a finite viscosity is also presented. The application of Taylor's and Mayer's hypotheses on the size and mechanism of liquid breakup from the unstable surface and the results of the instability analysis provide proportionality relationships between the droplet size and the wavelength of the wave having maximum growth rate, and between the rate of liquid entrainment and the flow and instability-growth parameters. The constants of proportionality in these relationships are determined from the use of existing experimental data. 20 references. (auth)

1976 (BNWL–568) BUILDUP OF RADIOISOTOPES EXTERNAL TO REACTOR CORE. Bunch, W. L.; Zwibel, H. S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1967. 10p. Dep. NTIS.

Relations have been derived and a computer program written to calculate the number of radioactive nuclei of any given species that will be located external to the core as a function of operating time for four input parameters. The input parameters are: (1) the initial number of target nuclei in the core that can be transmuted into the species of interest, (2) the rate of formation of the radioactive species, (3) the decay constant for the radioactive species, and (4) the rate of removal from the core. If the reactor is operated for a sufficient time interval, a secular equilibrium will be established external to the core for each radioactive species. Figures 1 and 2 present results for two typical reactions based on assumed input parameters. (auth)

1977 (EURFNR–999) SODIUM BOILING EXPERIMENTS IN A FUEL ELEMENT MODEL. Cramer, M.; Dorr, B. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK–1541. 66p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The first series of sodium boiling experiments performed on a model of a full-sized fuel element of the DEBENELUX Fast Breeder Reactor is described. The boiling events and the motion of bubbles in this element model are discussed by means of measured temperature curves. The experiments were conducted within the framework of safety assessments of fast sodium cooled reactors. It was shown that pressure stress exerted on the wall of the fuel element box through boiling and condensation impact is kept at such a low level that no destruction or unacceptable deformation of the parts should be anticipated. 6 references. (auth)

1978 (FRNC-CONF–40) HYDRAULIC AND THERMAL STUDY OF A FUEL ASSEMBLY. Demargne, F.; Lecocq, P. (Electricite de France, Chatou). 1972. 8p. (In French). (CONF-720648–15). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The cooling of fuel assemblies in a sodium cooled fast reactor (mixing problem) was studied. A hydraulic mockup operating with sodium, in which each pin could be heated individually by the Joule effect was built. Tracing was effected by temperature measurement. The experimental program and the interpretation method used are described, together with the test results. 5 references. (auth)

1979 MODERN CIRCULATING PUMPS. Poetschke, H. Getriebe Mot. Antriebselem.; 9: No. 5, 4; 22-3(1970). (In German).

A concise review is given on the development and the application of coolant pumps in the nuclear power reactors of the FRG. (INIS)

1980 PROSPECTS OF PRESTRESSED CONCRETE PRESSURE VESSELS FOR LIGHT-WATER REACTORS. Margen, Peter H.; Menon, Shankar (Aktiebolaget Atomenergi Nykoping, Sweden). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 24-5(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1981 EROSION BY SMALL LEAKS IN SODIUM WATER HEAT EXCHANGERS. Pugh, A. R. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 3, 263-9(Jul 1972).

A model is proposed of the events leading to material wastage during the reaction resulting from leaks in sodium-water heat exchangers. Using the model, a theory is developed of the mechanism of erosion by superheated water jets in which the erosion is due to the collapse of vapor bubbles on impact with the specimen surface. Relationships are derived between the rate of erosion and the variables water temperature, specimen separation and orifice diameter. Using duralumin and lead specimens, experimental erosion measurements are presented which are consistent with the theory. (auth)

Fuel Systems and Components

Refer also to abstracts 687, 728, 811, and 871.

1982 (AECL–4253) THISTLE: A PROGRAM TO DETERMINE THE THREE-DIMENSIONAL, STEADY-STATE TEMPERATURE AND HEAT FLUX DISTRIBUTIONS IN INHOMOGENEOUS NUCLEAR FUEL ELEMENTS. Crozier, R. J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1972. 34p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

This report describes the Fortran program THISTLE designed to determine the non-uniform, three-dimensional, steady-state temperature and heat flux distributions which arise in a solid or hollow heat generating circular cylinder of finite height. This cylinder contains one or more symmetrically distributed heat generating particles. The cylinder is enclosed by a tube whose external circumferential surface is cooled. The preparation of input data has been made particularly simple and graphical output may be obtained directly. The problem of the non-uniform heating of a fuel sheath containing PuO_2-UO_2 fuel is used as an illustration.

1983 (GEAP–13741) PERFORMANCE PREDICTIONS AND A DESCRIPTION OF THE OXIDE FUEL ELEMENT MODELING CODE BEHAVE-1. Gelhaus, F. E.; Stephen, J. D. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jul 1972. Contract AT(04-3)-189. 88p. Dep. NTIS.

The application of the BEHAVE-I modeling code to predicting fuel element diametral changes is detailed for General Electric fuel pins F2G, F2H, and F2V, irradiated in the EBR-II under Task F of the PA-10 contract. Highlighted by these analyses are the speculative mechanisms of in-situ change in the rate of neutron-induced cladding swelling apparently due to precipitate formation, and the presence of a high-pressure central void volume ("gas bottle" effect). A general parameter/sensitivity study is included to show the variation to be expected in the output (prediction) as the result of uncertainties in the input data. Code structure and logic and input-output formats are described to provide a user's manual for execution and modification of the program. (31 references) (auth)

1984 REVIEW OF THE ITALIAN ACTIVITIES FOR THE THERMAL RECYCLING OF PLUTONIUM. Schileo, G. (Comitato Nazionale per l'Energia Nucleare Plutonium Program, Rome). Nucl. Technol.; 16: No. 3, 360-6(Nov 1972).

A brief status report on the various activities conducted or in progress in Italy in the area of thermal recycling of plutonium in light-water moderated and cooled reactors is presented. The bulk of the activities was originally in the field of neutron physics. Full-scale prototypical fuel elements were developed, designed and built. A demonstration program on a substantial scale is in progress in an Italian power reactor. Sixteen plutonium elements were loaded in the core and generated some 10% of the power fed into the electric network. Two plutonium elements are undergoing the scheduled postirradiation tests, leaving fourteen of them in the core. 8 references. (auth)

1985 PROSPECTS FOR PLUTONIUM RECYCLE IN LWRs. Buckman, Frederick W. (Consumers Power Co., Jackson, Mich.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 4(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1986 SYMPOSIUM ON THE LIMITING ASPECTS OF FUEL ELEMENT PERFORMANCE IN WATER-COOLED POWER REACTORS, KJELLER, NORWAY, AUGUST 24–28, 1970. Nucl. Eng. Des.; 21: No. 2, 165-330(1972). (CONF-700858).

Included are 9 lectures on water cooled reactor fuel technology. A separate abstract was prepared for each lecture. (H.D.R.)

For abstracts of individual papers see: 657, 658, 687, 811, 812, and 1987–1990.

1987 OPERATION WITH FUEL MELTING. Freshley, M. D. (Battelle-Northwest, Richland, Wash.). Contract AT-(45-1)-1830. Nucl. Eng. Des.; 21: No. 2, 254-63(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

The basic technical feasibility of operating Zircaloy-clad pellet and vibrationally compacted oxide fuels with central melting has been demonstrated. Experimental Zircaloy-clad UO_2 fuel rods have been successfully irradiated under extreme operating conditions with peak heat ratings of 45 to 55 kW/ft ($\int_{0^\circ C}^{T_C} K d\theta$ = ~190 W/cm) and melting extending to 85% of the fuel radius or 70% of the cross-sectional area. Peak burnups as high as approximately 20,000 MWd/MTM have been achieved while operating with fuel-melting conditions. (23 references) (auth)

1988 HEAT TRANSFER AS LIMITING FACTOR IN WATER-COOLED NUCLEAR REACTORS. Kjaerheim, Gudolf (OECD, Halden, Norway). Nucl. Eng. Des.; 21: No. 2, 279-302(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

The importance of heat transfer in water-cooled nuclear reactors is discussed. Starting from a description of the complex phenomena of boiling and flow regimes in simple geometries, the mechanism of burnout is treated in some detail. The temperature threshold where there is an abrupt change in the rewetting properties of a hot surface is related to a phenomenon first described by Leidenfrost, but is also affected by local flow conditions. Transient operation beyond critical heat-transfer conditions may not necessarily result in physical burnout. Some well-known burnout correlations are described and examples of using the correlations to predict margins to burnout in reactor fuel channels are given. Existing burnout correlations are satisfactory only over a limited operating range and for a given geometry. Subchannel analysis may provide a more precise description of local coolant conditions, hopefully resulting in improved burnout predictions. (63 references) (auth)

1989 DESIGN OF FUEL ELEMENTS. Pickman, D. O. (United Kingdom Atomic Energy Authority, Preston, Eng.). Nucl. Eng. Des.; 21: No. 2, 303-17(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

Design features which may limit the performance of water-cooled power reactors are discussed. Apart from achieving its target in terms of reactivity life and thermal and hydraulic performance, a fuel element has done its job if it endures to its design burnup without release of fission products and in a fit condition for discharge and post-irradiation storage and handling. Attention is devoted only to rod bundle type fuel elements, which are used almost exclusively in present day power reactors. (9 references) (auth)

1990 BEHAVIOUR OF DEFECTIVE REACTOR FUEL. Locke, D. H. (United Kingdom Atomic Energy Authority, Preston Eng.). Nucl. Eng. Des.; 21: No. 2, 318-30(1972).

From Symposium on the limiting aspects of fuel element performance in water-cooled power reactors; Kjeller, Norway (24 Aug 1970). See CONF-700858.

Fuel element defects can be minimized by careful attention to design and development, choice of materials and method of operation. However there is always a finite chance of a fuel failure, as is recognized by both designers and operators. (auth)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

1991 SAFETY ANALYSES OF REACTOR PRESSURE VESSELS. Bartholome, G.; Dorner, H. (Siemens AG, Erlangen, Ger.). Nucl. Eng. Des.; 20: No. 1, 201-13(1972). (In German).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

An evaluation of the safety of nuclear reactor pressure vessels for pressurized water reactors to resist fracture is an important feature in ensuring nuclear reactor safety. This evaluation is performed using fracture mechanics. The linear, elastic and plastic stress distributions for plane stress and plane strain conditions are derived for the different modes of fracture. The concepts of the linear elastic fracture mechanics and of the crack-opening method are shown. A critical analysis of crack growth and of stress corrosion cracking extends the use of fracture mechanics. Design and calculation of reactor pressure vessels using brittle fracture concepts, estimation of permissible crack sizes for the specification of standards for inspection, hydrostatic pressure test and recurring inspections, and evaluation of the operating performance and life expectancy of nuclear reactor pressure vessels including crack growth and stress corrosion cracking are technical applications of fracture mechanics studies of reactor pressure vessels. Using the above derived data, the safety of reactor pressure vessels against fracture is shown by means of: crack size–stress diagrams; brittle fracture diagrams and ductile fracture diagrams, and operating stress diagrams. (auth)

Operation and Economics

1992 CONFERENCE ON NUCLEAR POWER FOR TOMORROW, ATLANTIC CITY, N. J., AUGUST 22–25, 1972. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 1-30 (1972). (CONF-720817).

Included are 37 summaries of papers on potential future nuclear power sources. Nuclear reactors are emphasized, and the development potential of various types is discussed. Each paper is title listed in NSA. (H.D.R.)

For abstracts of individual papers see: 278, 1788, 1918–1941, 1974, 1980, 1985, 1998–2000, 2067, 2068, 2173, 2178, and 2189.

1993 FUTURE IN NUCLEAR POWER: THE COSTS. Bainbridge, G. R. J. Brit. Nucl. Energy Soc.; 11: No. 3, 259-62(Jul 1972).

Electricity requirements in Britain to the end of this century and reasons for assuming that an increasing proportion of the generating capacity will be met by nuclear fuel are discussed. The economic aspects of nuclear power are considered and illustrated by a breakdown of capital and generating costs for both nuclear and fossil stations. Fusion power is briefly considered. (UK)

1994 OPERATIONAL RELIABILITY: AUTOMATIC COMPILATION AND ANALYSIS OF INFORMATION. Blin, A.; Guyot, C. (Services d'Electronique de Saclay, Gif-sur-Yvette, France). 25p. of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971). (In French).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR–90; CONF-710556.

1995 FUTURE DEVELOPMENT OF NUCLEAR ENERGY IN THE EUROPEAN COMMUNITY. Benzler, H. (Commission of the European Communities, Brussels). Nucl. Eng. Des.; 19: No. 1, 19-22(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The electric power requirements of the six Community member countries up to the year 2000 is estimated. Certain reasonable assumptions are then made to deduce the quantitative development of nuclear energy. Mention is also made of a number of incidental problems which are still to be cleared up before the required number of nuclear power plants can be built. Two programmes for the implementation of the Community's nuclear power plants are presented on the basis of the present outlook for the development of those reactor types which can be considered for industrial use. Both programmes are based on the assumption that until sometime in the 1980's, apart from a few prototypes, the only reactors which can enter into consideration will be of the light water type. (auth)

1996 TECHNICAL AND COMMERCIAL POLICY ASPECTS OF THE U.K. NUCLEAR FUEL CYCLE. Franklin, N. L. (British Nuclear Fuels Ltd., Risley). Nucl. Eng. Des.; 19: No. 1, 23-31(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The main aspects of nuclear fuel cycle services which are essential to the economics of any nuclear reactor programme are reviewed, and the need for industrial concerns to change their basis of operations from a national to an international environment involving collaboration with other companies, in order fully to utilise resources and to maintain viability as the industry develops, especially with regard to the development and exploitation of new reactor systems is examined. The influence of technology on the general development of the industry is considered as well as examples of procedures adopted for tackling specific technical problems. (auth)

Safety and Siting

1997 (IRS–F–11) RESEARCH IN THE FIELD OF REACTOR SAFETY ASSIGNED BY THE GOVERNMENT MINISTRY FOR ENGINEERING AND SCIENCE. Quarterly Report, April 1–June 30,

1972. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). 1972. 67p. (In German). Dep. NTIS (U. S. Sales Only).

1998 ACTIVE INTERVENTION IN NUCLEAR SAFETY. van Erp, J. B. (Argonne National Labs., Ill.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 25-6(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

1999 UNDERGROUND SITING OF NUCLEAR POWER PLANTS. Rogers, Franklyn C. (Harza Engineering Co., Chicago). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 28-9 (1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

2000 FLOATING OFFSHORE POWER GENERATING STATIONS. Ashworth, Joseph A. (Public Service Electric and Gas Co., Newark, N. J.); Nichols, Roger C. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 29-30(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

2001 PROCEEDINGS OF THE CREST SPECIALIST MEETING ON APPLICABILITY OF QUANTITATIVE RELIABILITY ANALYSIS OF COMPLEX SYSTEMS AND NUCLEAR PLANTS IN ITS RELATION TO SAFETY. Conference Held at Munich, May 26–28, 1971. Garching, Ger.; Technische Universitaet Muenchen (1971). 312p. (In French and English). (MRR–90; CONF-710556).

Twenty-two papers were presented at the conference. A separate abstract was prepared for each of 19. Three papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 899, 1994, 2002–2005, 2137–2142, 2190, 2191, and 2199–2203.

2002 USE OF PROBABILITY TECHNIQUES IN A REACTOR DESIGN OFFICE. Pugh, M. C. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 16.1-8 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR–90; CONF-710556.

A statistical approach to evaluate reactor safety and minimize the amount of non-operating, purely safety-related equipment is presented. It is shown that this type of approach can be applied from the initial design stages onward, providing better safety reliability than heretofore, and yet providing substantial economic savings. This method was employed in the analysis of the Steam Generating Heavy Water Reactor for three types of accidents: reactivity faults, cooling system failure leading to depressurization, and component failures leading to dangerous operating conditions even though cooling system remains in part. (J.M.J.)

2003 SYSTEM SAFETY ANALYSES OF COMPLEX SYSTEMS. Mieze, G. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp 17.1-19 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR–90; CONF-710556.

The general decision making process in system safety assessment is described. In this context, the necessary criteria and the problem of adequate information generation are discussed. The criteria is of qualitative or quantitative nature (maximum acceptable risk or hazard levels). Also, the information on the system is qualitative or quantitative in nature, depending on the type of criteria used. A system safety programme to assure the achievement of the safety objectives (i.e., the acceptable risk level) will be discussed. Analyses techniques as part of the system safety programme will be identified and explained to some extent. Emphasis is placed on the status of reliability in the framework of system safety program. Special attention is given to the implementation of analyses techniques for complex systems. 3 references. (auth)

2004 RELIABILITY ANALYSIS FOR SAFETY PURPOSES. Galvagni, R.; Tenaglia, G. (CNEN, Rome). pp 18.1-16 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR–90; CONF-710556.

While confirming the necessity of a reliability analysis in order to evaluate the safety level of a reactor which is going to be licensed, the practical difficulties in introducing a reliability assessment in licensing procedure are printed out. Such difficulties are mainly of historical-psychological and technical nature. In order to overcome some of these difficulties, an analysis method is proposed based on standard components and on an associated criterion of multiple failures. An application of one such method is given as an example to better explain its possibility of use for safety purposes. (auth)

2005 DEVELOPMENT IN THE APPLICATION OF RELIABILITY ANALYSIS IN REACTOR DESIGN AND SAFETY ASSESSMENT AND THE RESULTING PRACTICAL REQUIREMENTS. Vinck, W. (Commission of the European Communities, Brussels); Mauer, H. A.; Bastl, W.; Tenaglia, G. pp 19.1-18 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR–90; CONF-710556.

An outline is given of the most important problems which arise in the application of reliability analysis in design and safety assessment. Besides the definition of the problems, the methods available for evaluation are described, the resulting practical requirements, and the available statistical data discussed. The possibility of discovering shortcomings in the design or layout and of indicating effective measures for improvement are explained by simplified examples of numerical analyses of both the availability of a neutron system including measuring devices and shutdown devices without rod drives and of the availability of different core cooling systems. Emphasis is placed on the latest development mainly as far as the specific area of the collection of statistical data on failure and defect rates are concerned with regard to their applicability for a quantitative safety analysis. The type of information on field data to be obtained and the means of obtaining them must be planned in advance. The data, once collected must be analyzed and interpreted to be of use. A possible data collection technique applicable in nuclear power plants will be briefly discussed. 6 references. (auth)

2006 INFLUENCE OF DIFFERENT TECHNICAL SAFETY EQUIPMENTS FOR PRESSURIZED WATER REACTOR NUCLEAR POWER PLANTS ON THE LIBERATION OF RADIOACTIVE MATERIALS AND THEIR RELEASE TO ENVIRONMENT. Burkhardt, W.; Eichhorn, W.; Schimmel, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 15: No. 3, 89-94(Mar 1972). (In German).

The aspects of establishing the limiting values for radiation exposure due to nuclear power plants are discussed as a basis for further considerations. It is distinguished between normal and accidental operation as well as between individual radiation exposure and exposure of population. Moreover, the possibilities given by accident analysis according to the probabilistic principle for safety techniques in nuclear power plants are discussed. From the examples given, the effect of reliability of different safety equipment on the release of radioactive materials from a nuclear power plant is studied. 8 references. (auth)

Steam and Power Conversion System

2007 (FRNC-CONF-37) DIGITAL SIMULATION OF NUCLEAR STEAM GENERATORS. Bauer, E.; Larminaux, R.; Lemoine, M.; Sureau, H. (Electricite de France, Paris). 1972. 8p. (In French). (CONF-720648–11). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

A digital model of the dynamic performance of gas and pressure water reactors is described. The pulsating behavior of the heat exchanger originally intended for the Bugey graphite-gas reactor is explained. Water level instabilities in the Chooz PWR steam generator are analyzed under low output. (auth)

2008 (FRNC-CONF-42) HYDRAULIC AND THERMAL STUDY ON A STEAM GENERATOR MOCKUP. Lavalerie, C.; Bouju, J.-L. (Societe Babcock-Atlantique, Paris (France)). 1972. 9p. (In French). (CONF-720648–20). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

In order to study a steam generator for a sodium cooled fast reactor, a prototype 45 MW heat exchanger was built. The following tests were carried out: study of the generator sodium inlet

manifolds; flow study on a model simulating a section of the tube cluster; model simulating a sodium–water reaction taking place after a tube burst. (auth)

Commercial Power Reactors

Refer also to abstract 2174.

2009 HARTLEPOOL NUCLEAR POWER STATION. Lakin, N. O. E. (Taylor Woodrow Construction Ltd., Southall, Eng.). Civil Eng. Public Works Rev.; 67: No. 792, 733-4(Jul 1972).

Two of the new design features incorporated in the 1250 MW AGR nuclear power station being built at Hartlepool, U.K. are the pod-boiler concept and the method used of prestressing the concrete pressure vessels by winding steel wire around them. The plant is sited near a major population center which indicates official confidence in its safety. The building layout combines as many plant items as possible in one building complex and was influenced by the construction methods for the reactors, requirements for meeting dates for reactor fuelling and computer installation, and the need for maximum reduction in capital costs of installation. The main building houses the two prestressed concrete pressure vessels, each containing eight boiler pods, and the shielded facilities block which connects the charge face with the post irradiation fuel storage pond. The main structural elements are six reinforced concrete towers supporting the steel superstructure and the construction cranes. Sound foundations presented a major problem. Forty lined concrete shafts were required to transfer the load from the reactor to the solid sandstone bedrock below the site. Completion dates for the various buildings are given. (UK)

2010 CONFERENCE ON NUCLEAR ENERGY IN THE NETHERLANDS, PETTEN, NETHERLANDS, MAY 30 AND JUNE 7, 1972. Atoomenergie Haar Toepass.; 14: 163-232 (1972). (In Dutch). (CONF-720555).

Separate abstracts were prepared for each of the ten papers presented. (J.M.J.)

For abstracts of individual papers see: 413, 637, 2011–2016, 2143 and 2144.

2011 DEVELOPMENT IN THE WORLD ENERGY DEMAND. Hoog, H. Atoomenergie Haar Toepass.; 14: 163-71(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

A global view on the development of energy demand reveals a continuous and sharp increase. Energy patterns of the future, particularly until 1985, are studied as to primary energy, intermediate—and final forms of energy and the ultimate application of energy. Electric power plays an important role, in that its growth has been twice the growth of all primary energy. The question is raised whether our global energy resources, fossil and nuclear, can meet the increasing energy demand. (auth) (Netherlands)

2012 EXPERIENCES WITH AND PROSPECTS OF LIGHT-WATER REACTORS. Bakker, J. H. Atoomenergie Haar Toepass.; 14: 172-8(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

A survey is given of the trends in the production of electricity with light water reactors and their relation with conventional production methods, the development of other reactor types and their respective influences on the environment. (auth) (Netherlands)

2013 PROSPECTS OF FAST REACTORS. de Haas van Dorsser, A. H. Atoomenergie Haar Toepass.; 14: 178-82 (1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

The status of liquid metal fast breeder development in the world is reviewed. The next stage, in which 300 MW prototypes will be followed by 1,000 MW stations, is discussed, with particular reference to the Netherlands. (auth) (Netherlands)

2014 PROSPECTS OF OTHER REACTOR TYPES. Schoelvinck, R. G. Atoomenergie Haar Toepass.; 14: 183-92(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

A review is presented of the development of advanced converters and other breeder reactors. A brief description is given of the status of several of these reactor systems. Their role is indicated to the extension of fissionable material from the uranium and thorium resources. Finally the relative merits of these reactor systems are discussed in terms of fuel utilization, power cost and reactor safety. (auth) (Netherlands)

2015 NUCLEAR POWER RESEARCH IN THE NETHERLANDS. Goedkoop, J. A. Atoomenergie Haar Toepass.; 14: 193-203(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

Examples of nuclear reactor energy research in the Netherlands are presented. They pertain to the aqueous suspension reactor, development of spherepac fuel, sodium cooled fast reactors, high temperature reactors and thermo-nuclear research. (auth) (Netherlands)

2016 DUTCH NUCLEAR POWER INDUSTRY. van Veen, M. C. Atoomenergie Haar Toepass.; 14: 204-7(1972). (In Dutch).

From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

This article gives an impression of the Dutch industry's view of the future development of the power reactor market in the Netherlands. The conclusion is that only through international co-operation on an equal basis the Dutch industry will be able to develop, both in the area of heavy components and of nuclear systems. (auth) (Netherlands)

2017 TECHNIQUE AND ECONOMY IN QUALITY CONTROL OF LARGE REACTOR COMPONENTS. Dorner, H. (Siemens AG, Erlangen, Ger.); Hartz, K.; Trumpfheller, R. Atomwirt., Atomtech.; 17: No. 9-10, 524-7(1972). (In German).

The quality control of large reactor components claims highest significance for safety and economy of power plants. Test regulations in the Federal Republic of Germany cause significantly higher costs than those required by the American Society for Mechanical Engineers, which is based only on radiation examination. To lower the costs, a unified system of regulations is proposed. Reliability of quality control could be increased further if the temporal behavior of material were included. It would then be possible to take mechanical properties into consideration. (tr-auth)

2018 POWER REACTOR DEVELOPMENT STRATEGIES IN THE UNITED STATES. Du Temple, Octave J. (American Nuclear Society, Hinsdale, Ill.). Nucl. Eng. Des.; 19: No. 1, 33-40(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903–(Vol.19,No.1).

Strategies of the U. S. organizations that are developing and marketing light-water reactors and gas-cooled reactors are outlined. Probable enrichment policies to back up U. S. reactor sales are mentioned. Reviewed are environmental considerations and the need for technical information exchange and expedited nuclear standards development. Predictions concerning progress in U. S. fast-breeder reactor development are made. (auth)

2019 PRESSURIZED WATER REACTOR DEVELOPMENT, MECHANICAL-STRUCTURAL REQUIREMENTS, AND PROBLEMS. Keller, W. (Siemens AG, Erlangen, Ger.). Nucl. Eng. Des.; 19: No. 1, 41-54(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903–(Vol.19,No.1).

The present survey of pressurized water reactor development and the related mechanical-structural requirements and problems focuses on the following points: development trends in power density, burn-up and fuel costs; mechanical problems of reactor vessel and internals; development trends in loop capacity and live steam pressure; method of operation and effectiveness of the safety injection and core emergency cooling systems, and problems related to the containment structure. (auth)

Physics and Core Engineering

2020 (RISO–268) CALCULATIONS ON A BOILING WATER REACTOR AS A TEST OF THE RISOE REACTOR CODE COMPLEX. Hvidtfeldt Larsen, A. M.; Larsen, H.; Petersen, T. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1972. 102p. Dep. NTIS (U. S. Sales Only).

The boiling water reactor calculation methods used at Risø are described. A series of test calculations performed on the DRESDEN 1 reactor is presented. The code system used spans the area from 76-group isotopic cross sections via box calculations to three-dimensional overall calculations inclusive of the void and temperature distributions. 35 references. (auth)

Control Elements, Systems, and Instrumentation

2021 USE OF CONTROL BY BORIC ACID IN NUCLEAR POWER PLANTS WITH PRESSURIZED WATER REACTORS, SOME EXPERIENCE GAINED WITH THE USE OF BORIC ACID IN

THE RHEINSBERG NUCLEAR POWER PLANT. Hentschel, G. (VEB-Kernkraftwerke Greifswald, Rheinsberg, Ger.). Kernenergie; 15: No. 3, 85-9(Mar 1972). (In German).

Introduction of control by boric acid has essentially affected the technological development of pressurized water reactors in connection with the use of cluster control rods and has contributed to the fact that this type plays the dominant role nowadays. The main advantages and effects of control by means of boric acid are given. Aim and status of the works concerning introduction of boric acid control in the Rheinsberg nuclear power plant are discussed. 11 references. (auth)

2022 OPTIMUM DIGITAL CONTROL SYNTHESIS OF THE A-1 REACTOR OF THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION. Stirsky, P.; Karpeta, C. (Power Research Inst., Prague). pp 179-95 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

A generalized linearized stochastic model of state variables of thermokinetics of the A-1 reactor and the measured vector are described. For discrete state equations calculations of state, disturbance and control transition matrices are included. For control of coolant and maximum uranium temperature use is made of the change in radioactivity. The algorithm is defined for the calculation of feedback control matrices minimizing the quadratic performance criterion applied to the output coolant temperature, the maximum uranium temperature and reactivity. Since of the 10 state variables only 4 are measurable (input and output coolant temperature, coolant flow and neutron density), an estimate has to be made of the other 6. The algorithm of the calculation of the optimum filter and of Kalman's gain matrix are described. For the purposes of future analyses, the feedback control matrices for three values of sampling period, for two different optimization criteria and three types of excitation of the mathematical model are calculated. 9 references. (auth)

2023 ON-LINE COMPUTERS IN UK NUCLEAR STATIONS. Welbourne, D. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). pp 197-209 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The on-line computer system at the Wylfa nuclear power station, which is the final and largest version of the first generation of nuclear stations built in the United Kingdom, is described. Details of experience with the equipment and computer programs are given. In addition, the computer system and facilities to be provided for two of the latest AGR stations under construction are outlined. (auth)

2024 REVIEW OF THE INSTRUMENTATION OF THE BRITISH GAS-COOLED REACTOR POWER STATIONS. Cox, R. J. (Atomic Energy Establishment, Winfrith, Eng.). pp 211-17 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The considerable advances in design and method that have occurred in the instrumentation of the British gas-cooled reactor nuclear power stations since the first power stations came into operation in Britain at Calder Hall in 1956 are reviewed. Each of the main category of instrumentation used in the Magnox type of power station is discussed and data presented on the experiences, particularly where they have had some effect on plant availability or where the maintenance record warrants some comment. The instrumentation aspects of the advanced gas-cooled reactor (AGR) power stations now being built are briefly discussed. Some of the more unusual instrumentation problems that will arise in the commercial operation of high temperature gas-cooled reactors (HTR) are described. (auth)

2025 REVIEW OF INSTRUMENTATION ON THE WINFRITH SGHWR PROTOTYPE. Wilson, I. (Atomic Energy Establishment, Winfrith, Eng.). pp 219-28 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

Since the initial commissioning of the 100-MW(e) prototype Steam Generating Heavy Water Reactor power station at Winfrith during 1967 the plant has been in continuous operation, interspersed with a varied program of tests and modifications. The more important measurements needed for operation and protection are discussed in the light of the data that are presented arising from nearly four years of experience and comments made on how this experience could be exploited on larger commercial plants. (auth)

2026 PROCESS COMPUTER AND FUNCTIONAL GROUP CONTROL IN THE BIBLIS NUCLEAR POWER PLANT. Heining, U. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen). pp 245-50 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

With the increase in unit size the structural design of plants is becoming increasingly complicated and, particularly in the event of disturbances, less controllable. The great number of actuations and individual pieces of information constitute a heavy burden on the operators. To obtain maximum protection from maloperation, especially during the critical phases of start-up and shut-down, and the occurrence of faults, an electronic, decentralized, functional group control device will be installed at Biblis. The concept of automation, the system of equipment and the extent of automatic control are described. To evaluate the core instrumentation, compute the nuclear characteristic data of reactor operation and to supervise and record the process, it is intended to use a process computer. The layout of its program and equipment is also described. (auth)

2027 NEW INSTRUMENTS FOR NEUTRON FLUX MEASUREMENTS IN THE WUERGASSEN NUCLEAR POWER STATION. Stimler, M. (AEG-Telefunken, Frankfurt am Main). pp 287-91 of Nuclear Power Plant Control and Instrumentation. Vienna; International Atomic Energy Agency (1972).

From Meeting of nuclear power plant control and instrumentation; Vienna, Austria (15 Mar 1971). See STI/PUB-301; CONF-710340.

The nuclear power station at Würgassen is the first one in Germany with complete in-core instrumentation. This made it necessary to develop a new technique for neutron flux measurement in the intermediate range using the Campbell theorems. The signal in the power range is provided by the summed current of all in-core chambers. This signal is used in the safety system. Therefore excellent calibration of the detectors is important and has made the development of an accurate tip-calibration system necessary. (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

2028 PROTECTIVE COATINGS (PAINTS) FOR LIGHT WATER NUCLEAR REACTOR CONTAINMENT FACILITIES. ANSI N101.2-1972. New York; American Institute of Chemical Engineers (1972). 13p.

The purpose of this standard is to provide a common basis on which protective coatings (paints) for the surfaces of light water-moderated nuclear reactor containment facilities may be compared and selected by reproducible evaluation tests. Under the environmental conditions of nuclear reactor containment facilities, encompassing thermal Pressurized Water Reactors (PWR's) and Boiling Water Reactors (BWR's), coating may deteriorate by exposure to any one, all, or a combination of, the following conditions: ionizing radiation, contamination by radioactive nuclides and subsequent decontamination processes, chemical and water sprays, high-temperature, high-pressure steam, and abrasion or wear. This standard specifically applies to the interior surfaces of the containment for PWR's and of the primary containment for BWR's and to all equipment contained therein. The standard covers coatings applied to only the following materials: carbon steel, stainless steel, zinc-coated (galvanized) steel, aluminum, concrete, and masonry. (auth)

2029 BEHAVIOUR OF CONCRETE IN PRESTRESSED CONCRETE PRESSURE VESSELS. Browne, R. D.; Blundell, R. (Taylor Woodrow Construction Ltd., Southall, Eng.). Nucl. Eng. Des.; 20: No. 2, 429-75(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

In the design of prestressed concrete pressure vessels, long term concrete property data are required by the designer such that realistic estimates can be made of the vessels' 30-y stresses and deformations under the various operating conditions to which

it will be subjected. To achieve this aim, the shrinkage, short and long term deformation under load and thermal expansion behavior of the vessel concrete has to be determined under conditions simulating those likely in the structure. Concrete properties are examined in relation to vessel design. Results obtained from the test programmes carried out for the Wylfa and Hartlepool nuclear power stations are presented in relation to our understanding of each property obtained from a detailed literature analysis. The effect of temperature on three concrete properties of major importance in vessel design, e.g., compressive strength, thermal expansion and long term deformation under load (creep), is discussed at operational temperature up to 70°C. Consideration is also given, in the light of experimental data, on the effect of higher temperatures on these properties. (auth)

2030 THERMODYNAMICS OF INTERACTING CONTINUA WITH SURFACES AND CREEP ANALYSIS OF CONCRETE STRUCTURES. Bazant, Z. P. (Northwestern Univ., Evanston, Ill.). Nucl. Eng. Des.; 20: No. 2, 477-505(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

Creep, shrinkage and delayed thermal dilatations of concrete have source mainly in the interaction with water of the internal surfaces of solids in the cement paste microstructure. This interaction is believed to consist in changes of thickness or mass content of mono- and multimolecular adsorbed water layers confined between two solid adsorbent surfaces. These changes are brought by diffusion of water and other molecules along the layers. A consistent formulation of the above mechanism based on surface thermodynamics is presented and the isotropic macroscopic-stress–strain relations are derived. These relations indicate the form of the dependence of material parameters on pore humidity and temperature, and restrict considerably the number of possible forms of constitutive equation that would have to be assumed on a purely phenomenological basis if the material were regarded as general interacting continua in which strains are general functionals of the history of water content and temperature. A viscoelastic material with time-dependent properties is obtained as the special case for constant humidity and temperature. A suitable, numerically stable algorithm of step-by-step time integration of stress and strain problems is also presented. Analysis of experimental data aimed at numerical determination of the material parameters is presently in progress at Northwestern University. (auth)

2031 FINITE ELEMENT METHODS IN THE ANALYSIS OF REACTOR VESSELS. Zienkiewicz, O. C.; Owen, D. R. J.; Phillips, D. V.; Nayak, G. C. (Univ. of Wales, Swansea). Nucl. Eng. Des.; 20: No. 2, 507-41(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

The application of the finite element method to linear and non-linear problems in pressure vessel technology is presented. New developments for dealing with components such as liners, prestressing cables and reinforcement are outlined and some improvements possible in thin shell situations are discussed. A general solution technique for non-linear analysis is presented and applied to the problem of the plastic behaviour of steel pressure vessels. The failure of PCRVs by concrete cracking is then considered. Finally, the time-dependent phenomenon of creep is discussed. In all cases the theory is illustrated by practical examples. (auth)

Cooling Systems

2032 STUDIES ON PRIMARY PUMP FAILURE IN PWR POWER PLANTS. Zeisler, P. (Institut fuer Kraftwerke Vetschau, Berlin). Kernenergie; 15: No. 2, 57-9(Feb 1972). (In German).

After a brief discussion of the consequences of a primary pump failure in pressurized water reactor power plants a qualitative description of the model conception is given which underlies a computer program for the calculation of thermohydraulic core parameters in response to lost power supply for all primary pumps. (auth)

2033 BLOCK DIAGRAM OF NUCLEAR POWER PLANTS. Rousek, Jan; Skvarka, Peter; Rydzi, Stanislav (Vyskummy Ustav Energeticky, Bratislava). Jad. Energ.; 18: No. 7, 236-8(Jul 1972). (In Czech).

The modifications involving the secondary circuit of the power plant operated with the WWER-1000 reactor are reviewed. The plant consists of two 500 MW(e) generating units, operated with 3010 tons/hour of 60 kp/cm^2 saturated steam at the turbine inlet. It is recommended to superheat the steam with liquid or gaseous fossile fuel, in order to increase the thermal efficiency of the plant and the electricity output of each unit. This is of great importance for sites with a limited coolant water supply. Consideration is given to the use of exhaust- or gas-driven jet engines to provide power to be used within the power plant itself and to start up the system after an emergency shutdown. (TTT)

Fuel Systems and Components

2034 (AAEC/E-230) FISSION GAS RETENTION IN SPHERICAL BERYLLIUM OXIDE BASED FUEL ELEMENTS FOR THE CONCEPTUAL ABORIGINE REACTOR. Hanna, G. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1972. 28p. Dep. NTIS (U. S. Sales Only).

Fission gas release from spherical BeO-based fuel elements designed for the conceptual ABORIGINE reactor and from 200 micron diameter fuel particles of UO_2-ThO_2 solid solution has been measured by in-pile sweep capsule testing in the temperature range 600°C to 1000°C. Release parameters (R/B ratios) of 10^{-7} to 10^{-6} were measured on several fueled spheres, and 10^{-4} to 10^{-2} on bare fuel particles. Two spheres with bonded cladding maintained good gas retention at 1000°C for fast neutron doses (6×10^{20} nvt) which were three times that required of the ABORIGINE fuel element; however, the fission burnup (1.1 percent · U + Th) was a factor of nine below the design burnup. It has thus been shown that BeO coatings on fueled BeO spheres can in principle retain fission gases to the high standard required for ABORIGINE. (13 references) (auth)

2035 (AAEC/E-233) URANIUM SILICIDE FUEL IN HEAVY WATER MODERATED NATURAL URANIUM REACTORS. McCulloch, D. B.; Whitfield, J. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jul 1972. 27p. Dep. NTIS (U. S. Sales Only).

Some aspects of using natural U_3Si fuel elements in heavy water moderated reactors were studied with particular attention to reactivity limited fuel burnup. Both pressurized heavy water cooled and boiling light water cooled reactor types are considered. It is shown that with suitable redesign of the fuel element and/or pressure tube geometry to take advantage of the thermal properties of U_3Si, substantial improvements in fuel burnup may be expected in comparison with similar UO_2 fueled reactors. (12 references) (auth)

2036 (JN-72-18) XN-1, CRITICAL HEAT FLUX CORRELATION FOR BOILING WATER REACTOR FUEL. (Jersey Nuclear Co., Richland, Wash.). 1 Aug 1972. 96p.

An extensive experimental evaluation has been made of the critical heat flux (CHF) and hydraulic performance of commercial boiling water reactor fuel designs. A total of eight (8) electrically heated 16-rod bundles were used which had uniform axial and non-uniform local heat flux distributions. Nonuniform local heat flux distributions were used to simulate external and internal local flux peaking typical of BWR fuels. The rod bundles were constructed to evaluate the effects on CHF of Jersey Nuclear grid spacers, minimum grid spacers, and the effect of axial location of grid spacers. Data were obtained for mass velocities ranging from 0.3 to 2.0 × 10^6 lb/hr-ft^2, pressures of 600, 1000, and 1500 psig, and bundle average exit qualities ranging from 0 to 45%. 8 references. (auth)

Operation and Economics

2037 (DOCKET-50016-173) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Information on Leak Detected September 22, 1972 in No. 1 Steam Generator. (Power Reactor Development Co., Detroit, Mich.). 25 Oct 1972. 2p. Dep. NTIS.

2038 (DOCKET-50029-210) YANKEE NUCLEAR POWER STATION. Technical Specifications, Additional Information for Proposed Changes 102, Supplement 1 and 103. (Yankee Atomic Electric Co., Westboro, Mass.). 25 Oct 1972. 4p. Dep. NTIS.

Additional information is presented concerning replacement fuel rods in a Type B Zircaloy fuel element assembly. (D.C.C.)

2039 (DOCKET-50133-98) HUMBOLDT BAY POWER PLANT, UNIT 3. Authorization to Install, Test, and Operate Proposed Modified Off-Gas System. (Directorate of Licensing (AEC), Washington, D. C.). 26 Oct 1972. 2p. Dep. NTIS.

2040 (DOCKET-50146-113) SAXTON NUCLEAR EXPERIMENTAL REACTOR PROJECT. Operating Report for the Period, March 1, 1972-August 31, 1972. (Saxton Nuclear Experimental Corp., Pa.). 27 Oct 1972. 38p. Dep. NTIS.

2041 (DOCKET-50155-128) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change No. 32. (Directorate of Licensing (AEC), Washington, D. C.). 31 Oct 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the leakage limits for the primary cooling system. (D.C.C.)

2042 (DOCKET-50155-129) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Proposed Change No. 31, Additional Information. (Consumers Power Co., Jackson, Mich.). 1 Nov 1972. 13p. Dep. NTIS.

Information is presented concerning loss of coolant accident analysis for reactor operations with Reload G fuel elements. (D.C.C.)

2043 (DOCKET-50213-165) HADDAM NECK PLANT, UNIT 1. Defect in Reactor Coolant Pump Flywheel. (Directorate of Regulatory Operations (AEC), Washington, D. C.). 25 Oct 1972. 20p. Dep. NTIS.

2044 (DOCKET-50220-111) NINE MILE POINT NUCLEAR STATION, UNIT 1. Water Level Sensors Outside Allowable Tolerance. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 31 Oct 1972. 2p. Dep. NTIS.

2045 (DOCKET-50237-270) DRESDEN NUCLEAR POWER STATION, UNIT 2. Drifting of Main Steam Line Low Pressure Switches. (Commonwealth Edison Co., Morris, Ill. (USA)). 26 Oct 1972. 1p. Dep. NTIS.

2046 (DOCKET-50237-271) DRESDEN NUCLEAR POWER STATION, UNIT 2. Chimney Monitoring System Not in Operation, Setpoints of Low Pressure Switches Drifted Below Specification. (Commonwealth Edison Co., Chicago, Ill.). 3 Nov 1972. 5p. Dep. NTIS.

2047 (DOCKET-50237-272) DRESDEN NUCLEAR POWER STATION, UNIT 2. No. 1 Turbine Control Valve Fast-Acting Solenoid Would Not Actuate. (Commonwealth Edison Co., Chicago, Ill.). 27 Oct 1972. 2p. Dep. NTIS.

2048 (DOCKET-50244-123) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Proposed Change 7. (Rochester Gas and Electric Corp., N. Y.). 27 Oct 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the quadrant power tilt limits. (D.C.C.)

2049 (DOCKET-50249-167) DRESDEN NUCLEAR POWER STATION, UNIT 3. Abnormal Occurrences, August 1, 1972, October 5, 1972, and October 20, 1972. (Commonwealth Edison Co., Morris, Ill. (USA)). 27 Oct 1972. 3p. Dep. NTIS.

Information is presented concerning the incorrect calibration of offgas monitoring instrument, incorrect calibration of emergency core cooling system low pressure switches, and failure of the isolation condenser inboard steam isolation valve. (D.C.C.)

2050 (DOCKET-50254-134) QUAD-CITIES STATION, UNITS 1 AND 2. Special Report No. 5, Torus Ring Header Support Failure. (Commonwealth Edison Co., Chicago, Ill.). 26 Oct 1972. 61p. (DOCKET-50265-125). Dep. NTIS.

2051 (DOCKET-50254-135) QUAD-CITIES STATION, UNIT 1. 1B Core Spray Pump Failed to Start. (Commonwealth Edison Co., Chicago, Ill.). 31 Oct 1972. 3p. Dep. NTIS.

2052 (DOCKET-50255-110) PALISADES PLANT. Failure of Seal Mechanism of Control Rod Drive Mechanism No. 19. (Consumers Power Co., Jackson, Mich.). 2 Nov 1972. 4p. Dep. NTIS.

2053 (DOCKET-50261-118) H. B. ROBINSON UNIT 2. Breach of Containment Integrity During Reactor Operation. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 1 Nov 1972. 3p. Dep. NTIS.

2054 (DOCKET-50263-156) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Technical Specifications, Change No. 3. (Directorate of Licensing (AEC), Washington, D. C.). 31 Oct 1972. 2p. Dep. NTIS.

Revised technical specifications are presented concerning a reduction in the discharge head pressure for the residual heat removal service water pump. (D.C.C.)

2055 (DOCKET-50265-126) QUAD-CITIES STATION, UNIT 2. Special Report 2, Jet Pump Operability. (Commonwealth Edison Co., Chicago, Ill.). 30 Oct 1972. 51p. Dep. NTIS.

2056 (DOCKET-50266-88) POINT BEACH NUCLEAR PLANT, UNIT 1. Fuel Examination. (Wisconsin Electric Power Co., Milwaukee). 24 Oct 1972. 2p. Dep. NTIS.

2057 (DOCKET-50269-68) OCONEE NUCLEAR STATION, UNITS 1 AND 2. License Application. (Duke Power Co., Charlotte, N. C.). 1 Dec 1966. 70p. (DOCKET-50270-56). Dep. NTIS.

2058 (DOCKET-50269-78) OCONEE NUCLEAR STATION, UNIT 1. Reactor Coolant Incident Report. (Duke Power Co., Charlotte, N. C.). 4 Apr 1972. 8p. Dep. NTIS.

2059 (DOCKET-50271-108) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrence AO-72-07, AO-72-08. (Vermont Yankee Nuclear Power Corp., Rutland). 20 Oct 1972. 2p. Dep. NTIS.

Information is presented on the excessive time to energize the relief valve initiation time delay relay, and the failure of a main steam relief valve bellows. (D.C.C.)

2060 (DOCKET-50271-111) VERMONT YANKEE NUCLEAR POWER STATION. Action Taken to Correct Item of Noncompliance Brought to Attention Following Inspections of July 13-14 and 27-28, 1972. (Vermont Yankee Nuclear Power Corp., Rutland). 6 Oct 1972. 6p. Dep. NTIS.

Additional information is presented concerning the inspection of a containment purge supply valve. (D.C.C.)

2061 (DOCKET-50271-112) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrence AO-72-09. (Vermont Yankee Nuclear Power Corp., Rutland). 27 Oct 1972. 3p. Dep. NTIS.

Information is presented concerning the incorrect pressure set points for steam line differential pressure switches. The switches are part of the reactor core isolation cooling system. (D.C.C.)

2062 (DOCKET-50293-97) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-13. (Boston Edison Co., Mass.). 27 Oct 1972. 2p. Dep. NTIS.

The failure of a main steam line relief valve to close during a scheduled startup test is described. (D.C.C.)

2063 (DOCKET-50293-98) PILGRIM NUCLEAR POWER STATION. Unusual Occurrence UO-72-8. (Boston Edison Co., Mass.). 3 Nov 1972. 2p. Dep. NTIS.

Information is presented concerning the failure of the "D" salt service water pump. Repairs are described. (D.C.C.)

2064 (DOCKET-50321-55) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Figures 2.2, 2.3, and 2.4 for DOCKET-50321-51. (Georgia Power Co., Atlanta). 30 Oct 1972. 4p. Dep. NTIS.

Additional information concerning pressure vessel repairs is presented. (D.C.C.)

2065 (ORO-4203-1) PROCEEDINGS OF THE NUCLEAR TECHNICIAN MANPOWER SYMPOSIUM, ATLANTA, GEORGIA, MAY 25-26, 1972. (Southern Interstate Nuclear Board, Atlanta, Ga.). Oct 1972. 93p. (CONF-720547). Dep. NTIS.

Papers on the findings of recent surveys of present and future demands for nuclear technicians are presented. The implications of supply and demand for a regional manpower management information system are discussed. (J.M.J.)

2066 IEEE TRIAL-USE GUIDE: GENERAL PRINCIPLES FOR RELIABILITY ANALYSIS OF NUCLEAR POWER GENERATING STATION PROTECTION SYSTEMS. ANSI N41.4 (IEEE Std 352-1972). New York; Institute of Electrical and Electronics Engineers, Inc. (1972). 46p.

Designers and operators of nuclear power plant protection systems, and the concerned regulatory groups, are provided with the essential aspects of the methods and procedures of reliability engineering as applicable to protection systems. Through the application of the principles given herein, systems may be analyzed, acceptable test intervals established, results reconciled with reliability objectives, and the analyses suitably documented. The mathematical principles presented are applicable to the analysis of the effects of random failures on protection system reliability during any phase of a protection system's lifetime. They are especially intended for use and have their greatest value during the design phase, when that reliability engineering can have the greatest effect for enhancing safety. They may also be applied during the preoperational phase or at any time during the normal lifetime of a system. (21 references) (auth)

2067 PEACH BOTTOM OPERATING EXPERIENCE. Birely, W. C. (Philadelphia Electric Co.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 5(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

2068 FORT ST. VRAIN CONSTRUCTION AND OPERATING EXPERIENCE. Habush, Alfred L. (Gulf General

Atomic, San Diego, Calif.); Walker, Richard F. Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 5-6(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

2069 PICKERING: THE FIRST YEAR. Nucl. Eng. Int.: 17: No. 193, 475-8(Jun 1972).

A description is given of the performance of the Pickering, heavy water, natural uranium, reactor during its first year of operation. High capacity factors were achieved by both units and heavy water losses were well within design limits. Problems encountered during commissioning and operation are discussed. (UK)

Safety and Siting

Refer also to abstract 257.

2070 (COO-2158-5) INVESTIGATION OF THE INFLUENCE OF THERMAL DISCHARGE FROM A LARGE ELECTRIC POWER STATION ON THE TEMPERATURE AND NEAR-SHORE CIRCULATION OF LAKE MICHIGAN. Quarterly Progress Report, July 1, 1972-September 30, 1972. Mortimer, C. H.; Sato, G. K. (Wisconsin Univ., Milwaukee. Center for Great Lakes Studies). 1972. Contract AT(11-1)-2158. 25p. Dep. NTIS.

The program for the study of the effects of the thermal effluents from a large power plant on lake temperature and circulation is described. Data, data gathering methods, and instrumentation are discussed. (J.M.J.)

2071 (DOCKET-50003-134) INDIAN POINT STATION, UNIT 1. Technical Specification, Additional Information Relative to Change. (Consolidated Edison Co. of New York, Inc., New York). 19 Oct 1972. 2p. Dep. NTIS.

2072 (DOCKET-50003-135) INDIAN POINT STATION, UNIT 1. Action Taken to Correct the Items of Noncompliance Brought to Attention Following Inspection of June 13, 14, 15, 16, 19 and 22, 1972. (Consolidated Edison Co. of New York, Inc., New York). 26 Sep 1972. 7p. Dep. NTIS.

2073 (DOCKET-50003-136) INDIAN POINT STATION, UNIT 1. Effect, if Any, of Flooding Caused by Piping in the Turbine Hall Superheater Building on Engineered Safety Systems. (Consolidated Edison Co. of New York, Inc., New York). 31 Oct 1972. 3p. Dep. NTIS.

2074 (DOCKET-50029-208) YANKEE NUCLEAR POWER STATION. Abnormal Occurrences AO-72-17 and AO-72-18. (Yankee Atomic Electric Co., Rowe, Mass.). 24 Oct 1972. 4p. Dep. NTIS.

2075 (DOCKET-50029-209) YANKEE NUCLEAR POWER STATION. Proposed Change 102. (Yankee Atomic Electric Co., Westboro, Mass.). 25 Oct 1972. 2p. Dep. NTIS.

2076 (DOCKET-50171-108) PEACH BOTTOM ATOMIC POWER STATION, UNITS 1, 2, AND 3. Wall Thickness of Nuclear Service Valves. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 10 Oct 1972. 9p. (DOCKET-50277-67; DOCKET-50278-67). Dep. NTIS.

2077 (DOCKET-50245-170) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence AO-72-25. (Millstone Point Co., Hartford, Conn.). 25 Oct 1972. 2p. Dep. NTIS.

2078 (DOCKET-50249-166) DRESDEN NUCLEAR POWER STATION, UNIT 3. Responses to Environmental Questions of September 15, 1972. (Commonwealth Edison Co., Chicago, Ill.). 17 Oct 1972. 226p. Dep. NTIS.

2079 (DOCKET-50250-99) TURKEY POINT PLANT, UNITS 3 AND 4. Proposed Changes in Technical Specifications. (Florida Power and Light Co.). 19 Oct 1972. 5p. (DOCKET-50251-79). Dep. NTIS.

Changes are proposed in the technical specifications for the environmental radiological surveillance program for the Turkey Point Power Reactor, Units 3 and 4. (H.D.R.)

2080 (DOCKET-50250-100) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 52. (Florida Power and Light Co.). 24 Oct 1972. 5p. (DOCKET-50251-80). Dep. NTIS.

The final safety analysis report for the Turkey Point Power Reactor, Units 3 and 4 is supplemented by the submission of revised information. (H.D.R.)

2081 (DOCKET-50254-133) QUAD-CITIES STATION, UNITS 1 AND 2. Special Report No. 4, Drywell to Suppression Chamber Vacuum Breaker Modifications. (Commonwealth Edison Co., Chicago, Ill.). 20 Oct 1972. 29p. (DOCKET-50265-124). Dep. NTIS.

2082 (DOCKET-50255-107) PALISADES PLANT. Technical Specifications, Change 1. (Directorate of Licensing (AEC), Washington, D. C.). 27 Oct 1972. 4p. Dep. NTIS.

2083 (DOCKET-50255-108) PALISADES PLANT. No Potential for Flooding That Would Adversely Affect Safety Related Equipment. (Consumers Power Co., Jackson, Mich.). 26 Oct 1972. 2p. Dep. NTIS.

2084 (DOCKET-50255-109) PALISADES PLANT. Stress Analysis of Main Steam Safety Valves, Additional Information. (Consumers Power Co., Jackson, Mich.). 31 Oct 1972. 4p. Dep. NTIS.

2085 (DOCKET-50261-117) H. B. ROBINSON UNIT 2. Axial Xenon Oscillations. (Carolina Power and Light Co., Raleigh, N. C.). 16 Oct 1972. 3p. Dep. NTIS.

2086 (DOCKET-50266-87) POINT BEACH NUCLEAR PLANT, UNIT 1. Technical Specification, Request for Change 5. (Wisconsin Electric Power Co., Milwaukee). 17 Oct 1972. 14p. Dep. NTIS.

Revised technical specifications are presented concerning the inspection and calibration schedules for instrumentation, and testing and sampling schedules for equipment and systems. (D.C.C.)

2087 (DOCKET-50269-67) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Action Taken With Respect to Matters the Subject of Letter of August 24, 1972. (Directorate of Regulatory Operations (AEC), Atlanta, Ga. (USA). Region II). 24 Oct 1972. 8p. (DOCKET-50270-55; DOCKET-50287-50). Dep. NTIS.

Additional information is presented concerning quality control procedures and requirements for radiographs. (D.C.C.)

2088 (DOCKET-50269-69) OCONEE NUCLEAR STATION, UNITS 1 AND 2. Safety Analysis Report, Amendment 3. (Duke Power Co., Charlotte, N. C.). 29 Apr 1967. 14p. (DOCKET-50270-57). Dep. NTIS.

Revised and additional data are presented concerning safety aspects of the reactor. (D.C.C.)

2089 (DOCKET-50269-70) OCONEE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 2. (Duke Power Co., Charlotte, N. C.). 18 Apr 1967. 176p. (DOCKET-50270-58). Dep. NTIS.

Requested information is presented concerning the power conversion system, electrical system, engineered safeguards, cooling system, containment system, and core physics. (D.C.C.)

2090 (DOCKET-50269-71) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 5. (Duke Power Co., Charlotte, N. C.). 20 Jun 1967. 24p. (DOCKET-50270-59; DOCKET-50287-51). Dep. NTIS.

Revised and additional data are presented concerning design parameters and operations aspects of the reactors. (D.C.C.)

2091 (DOCKET-50269-72) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Report of Advisory Committee on Reactor Safeguards. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 11 Jul 1967. 3p. (DOCKET-50270-60; DOCKET-50287-52). Dep. NTIS.

2092 (DOCKET-50269-73) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Safety Evaluation, Instrumentation and Power. (Duke Power Co., Charlotte, N. C.). 3 Aug 1967. 12p. (DOCKET-50270-61; DOCKET-50287-53). Dep. NTIS.

2093 (DOCKET-50269-74) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Issuance of Provisional Construction Permit Nos. CPPR-33, CPPR-34, and CPPR-35. (Division of Reactor Licensing (AEC), Washington, D. C.). 6 Nov 1967. 3p. (DOCKET-50270-62; DOCKET-50287-54). Dep. NTIS.

2094 (DOCKET-50269-75) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Amendment 25, Revision 15, Revised Figures. (Duke Power Co., Charlotte, N. C.). 8 Jan 1971. 8p. (DOCKET-50270-63; DOCKET-50287-55). Dep. NTIS.

Additional diagrams concerning the arrangement of equipment and structures are presented. (D.C.C.)

2095 (DOCKET-50269-76) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Safety Analysis Report, Amendment 25, Figures 4 and 7. (Duke Power Co., Charlotte, N. C.). 26 Jan 1971. 3p. (DOCKET-50270-64; DOCKET-50287-56). Dep. NTIS.

Additional information is presented concerning the cooling system. (D.C.C.)

2096 (DOCKET-50271-109) VERMONT YANKEE NUCLEAR POWER STATION. Final Safety Analysis Report, Proposed Change. (Vermont Yankee Nuclear Power Corp., Rutland). 12 Oct 1972. 6p. Dep. NTIS.

Revised technical specifications are presented concerning the primary containment isolation system actuation logic for the main steam isolation valve. (D.C.C.)

2097 (DOCKET-50271-110) VERMONT YANKEE NUCLEAR POWER STATION. Proposed Method of Controlling Combustible Gases Through Dilution. (Vermont Yankee Nuclear Power Corp., Rutland). 28 Apr 1972. 3p. Dep. NTIS.

2098 (DOCKET-50271-113) VERMONT YANKEE NUCLEAR POWER STATION. No Degredation of Engineered Safety Features Due to Flooding. (Vermont Yankee Nuclear Power Corp., Rutland). 1 Nov 1972. 1p. Dep. NTIS.

2099 (DOCKET-50272-43) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 190p. (DOCKET-50311-43). Dep. NTIS.

The environmental effects of construction and operation of the Salem Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

2100 (DOCKET-50272-44) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 16. (Public Service Electric and Gas Co., Newark, N. J.). 1 Nov 1972. 221p. (DOCKET-50311-44). Dep. NTIS.

Revised and requested data are presented concerning safety analysis, personnel, auxiliary systems, site, quality assurance program, power conversion system shielding, and performance evaluation of the emergency core cooling system. (D.C.C.)

2101 (DOCKET-50277-65) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection of May 23-26, 1972. (Philadelphia Electric Co., Pa.). 22 Sep 1972. 22p. (DOCKET-50278-65). Dep. NTIS.

Information is presented concerning items of noncompliance to quality assurance requirements during construction. (D.C.C.)

2102 (DOCKET-50285-74) FORT CALHOUN STATION, UNIT 1. Steam Line Break Accident. (Omaha Public Power District, Nebr.). 17 Oct 1972. 4p. Dep. NTIS.

2103 (DOCKET-50285-75) FORT CALHOUN STATION, UNIT 1. Discussion of Items of Apparent Noncompliance Brought to Attention in Letter of September 18, 1972. (Directorate of Regulatory Operations (AEC), Denver, Colo. Region IV). 25 Oct 1972. 7p. Dep. NTIS.

Information is presented concerning noncompliance to quality assurance requirements during construction. (D.C.C.)

2104 (DOCKET-50285-76) FORT CALHOUN STATION, UNIT 1. Reactor Building Compartments Differential Pressure Analysis. (Omaha Public Power District, Nebr.). 30 Oct 1972. 3p. Dep. NTIS.

2105 (DOCKET-50289-73) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Action Taken to Correct Items of Noncompliance Brought to Attention Following Inspection of July 11-14, 1972. (Metropolitan Edison Co., Reading, Pa.). 12 Oct 1972. 7p. (DOCKET-50320-33). Dep. NTIS.

Additional information is presented concerning corrected quality assurance requirements for site design drawings and equipment storage. (D.C.C.)

2106 (DOCKET-50289-74) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 32. (Metropolitan Edison Co., Reading, Pa.). 24 Oct 1972. 81p. Dep. NTIS.

Requested and revised information is presented concerning the cooling system, emergency core cooling system, control system, fuel handling system, emergency plans, auxiliary systems, and main steam line safety valves. (D.C.C.)

2107 (DOCKET-50293-95) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-11. (Boston Edison Co., Mass.). 24 Oct 1972. 1p. Dep. NTIS.

2108 (DOCKET-50293-96) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-12. (Boston Edison Co., Mass.). 25 Oct 1972. 1p. Dep. NTIS.

2109 (DOCKET-50298-55) COOPER NUCLEAR STATION. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 165p. Dep. NTIS.

The environmental effects of construction and operation of the Cooper Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

2110 (DOCKET-50302-56) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNITS 3 AND 4. Environmental Status Report, January to June 1972. (Florida Power Corp., St. Petersburg). 1972. 85p. (DOCKET-50303-11). Dep. NTIS.

2111 (DOCKET-50309-74) MAINE YANKEE ATOMIC POWER STATION. Technical Specification, Change Request. (Maine Yankee Atomic Power Co., Westboro, Mass.). 26 Oct 1972. 1p. Dep. NTIS.

2112 (DOCKET-50313-56) ARKANSAS NUCLEAR ONE, UNIT 1. Draft Environmental Statement. (Arkansas Power and Light Co., Little Rock). Oct 1972. 309p. Dep. NTIS.

The environmental effects of construction and operation of the Arkansas Nuclear One Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

2113 (DOCKET-50317-63) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 27. (Baltimore Gas and Electric Co., Md.). 20 Oct 1972. 111p. (DOCKET-50318-60). Dep. NTIS.

The final safety analysis report for the Calvert Cliffs Power Reactor, Units 1 and 2 is amended by the submission of revised and requested additional information. (H.D.R.)

2114 (DOCKET-50321-54) EDWIN I. HATCH NUCLEAR PLANT, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 203p. (DOCKET-50326-30). Dep. NTIS.

The environmental effects of construction and operation of the Edwin I. Hatch Power Reactor, Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography, and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (H.D.R.)

2115 (DOCKET-50321-56) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 20. (Georgia Power Co., Atlanta). 1 Nov 1972. 535p. Dep. NTIS.

Revised and requested data are presented concerning personnel, structures, auxiliary systems, core physics, instrumentation, containment structures, site, and proposed technical specifications. (D.C.C.)

2116 (DOCKET-50327-29) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Possible Result of Failure of Noncategory I Equipment. (Tennessee Valley Authority, Chattanooga). 24 Oct 1972. 3p. (DOCKET-50328-27). Dep. NTIS.

2117 (DOCKET-50331-59) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 7. (Iowa Electric Light and Power Co., Cedar Rapids). 20 Oct 1972. 493p. Dep. NTIS.

Requested information on the Duane Arnold Power Reactor is

presented under the following topics: reactor; emergency core cooling system; electrical system; auxiliary systems; power conversion system; safety analysis; and quality assurance program. (D.C.C.)

2118 (DOCKET-50333-60) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 15. (Power Authority of the State of New York. Niagara Mohawk Power Corp., Syracuse, N. Y.). 25 Oct 1972. 39p. Dep. NTIS.

Revised and additional data are presented concerning radioactive effluents during coolant loss accidents, personnel qualifications, pressure vessel stress limits, and radioactive waste disposal systems. (D.C.C.)

2119 (DOCKET-50334-37) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 2. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 211p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented concerning the reactor site. (D.C.C.)

2120 (DOCKET-50334-38) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 3. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 300p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented under the following topics: site; reactor kinetics; and design characteristics. (D.C.C.)

2121 (DOCKET-50334-39) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 4. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 452p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented under the following broad topics: cooling system; containment systems; and engineered safeguards. (D.C.C.)

2122 (DOCKET-50334-40) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 5. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 420p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented under the following topics: instrumentation; control system; electrical systems; and auxiliary systems. (D.C.C.)

2123 (DOCKET-50334-41) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 6. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 331p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented under the following topics: power conversion systems; radioactive waste disposal systems; radiation protection; conduct of operations; and initial tests. (D.C.C.)

2124 (DOCKET-50334-43) BEAVER VALLEY POWER STATION, UNIT 1. Final Safety Analysis Report, Volume 8. (Duquesne Light Co., Pittsburgh, Pa.). 27 Oct 1972. 501p. Dep. NTIS.

Information on the Beaver Valley Power Reactor Unit 1 is presented under the following topics: effects of high pressure turbine rotor fracture and low pressure turbine disc fractures at design overspeed; radiation sources; heat transfer coefficients for the LOCTA-R2 core thermal analysis; normal operation and operational transients; technical specifications; quality assurance program; seismic design of structures; and emergency plan. (D.C.C.)

2125 (DOCKET-50358-42) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Construction Permit CPPR-88. (Directorate of Licensing (AEC), Washington, D. C.). 27 Oct 1972. 6p. Dep. NTIS.

2126 (DOCKET-50363-41) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 23. (Jersey Central Power and Light Co., Morristown, N. J.). 23 Oct 1972. 10p. Dep. NTIS.

Requested additional information is presented on the containment pressure analysis during loss of coolant accidents for the Forked River Power Reactor, Unit 1. (H.D.R.)

2127 (DOCKET-50369-29) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 393p. (DOCKET-50370-29). Dep. NTIS.

The environmental effects of construction and operation of the McGuire Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

2128 (DOCKET-50373-28) LA SALLE COUNTY STATION, UNITS 1 AND 2. Potential for Catastrophic Damage from Flooding. (Commonwealth Edison Co., Chicago, Ill.). 20 Oct 1972. 2p. (DOCKET-50374-27). Dep. NTIS.

2129 (DOCKET-50382-40) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 25. (Louisiana Power and Light Co., New Orleans). 20 Oct 1972. 91p. Dep. NTIS.

The preliminary safety analysis report for the Waterford Power Reactor, Unit 3 is amended by the submission of revised and requested additional information. (H.D.R.)

2130 (DOCKET-50382-41) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Oct 1972. 199p. Dep. NTIS.

The environmental effects of construction and operation of the Waterford Power Reactor, Unit 3 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (H.D.R.)

2131 (DOCKET-50390-26) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 17. (Tennessee Valley Authority, Chattanooga). 19 Oct 1972. 68p. (DOCKET-50391-26). Dep. NTIS.

The preliminary safety analysis report for the Watts Bar Power Reactor, Units 1 and 2 is amended by the submission of revised and additional information. (H.D.R.)

2132 (DOCKET-50404-25) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 10. (Virginia Electric and Power Co., Richmond). 26 Oct 1972. 198p. (DOCKET-50405-25). Dep. NTIS.

Revised and requested data on the North Anna Power Reactor Units 3 and 4 are presented concerning electrical system, instrumentation, containment system, cooling system, quality assurance program, power conversion system, auxiliary systems, engineered safeguards, and safety analysis. (D.C.C.)

2133 (IRS-W-4) SYSTEMATIC REGISTRATION AND EVALUATION OF FAILURES. Fehndrich, W.; Feldmann, J.; Franzen, L. F.; Stoll, A. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). May 1972. 69p. (In German). Dep. NTIS (U. S. Sales Only).

The problems of systematic registration and evaluation of failures in nuclear installations are reviewed. As a starting point, the common task of systematic registration of all pertinent information was chosen. The original data are primarily to be found with the owners of nuclear installations. However, the interests of consultants, manufacturers and insurers require that the registration of further information be taken into account. This results in a common task for all parties contributing to a safe and economic development of nuclear power. Understandably, the contents and channels of information have to be regulated in such a way that they correspond to a utility's capacities to the differing requirements and prevent any misuse. Solutions to technical questions in connection with a unified classification system have been worked out. The results obtained so far appear to take important aspects into account. The inclusion of remaining requirements should be possible in the near future. Practical experience is available in major areas. Economic optimization of systematic registration and evaluation of failures is still required. If this is also successfully completed, owners, consultants, manufacturers and insurers will have at their disposal another valuable tool. (19 references) (auth)

2134 (RISO-M-1533) HEATING IN A REACTOR FUEL ELEMENT ROD UNDER TRANSIENT CONDITIONS, PART II, DINO. TEMPERATURES DURING A LOSS OF COOLANT ACCIDENT. Abel-Larsen, H.; Lolk Larsen, M. (Danish Atomic Energy Commission, Risoe. Research Establishment). 1 Sep 1972. 46p. Dep. NTIS (U. S. Sales Only).

A computer program to calculate the temperatures in a fuel rod subject to a loss of coolant accident is described. The program

requires discrete information of the coolant channel hydraulic history stored on an external storage device, magnetic tape, or data cards. The temperature response of the fuel rod is described in a finite difference formulation. The solution of the finite difference scheme is performed by the alternating directional implicit method which is always stable and well suited to handle large equation systems. The program determines the heat transfer coefficients along the channel based upon the hydraulic history and several heat transfer correlations in the program. The heat fluxes are computed through all internal and external surfaces. The decay of power in the fuel rod during the blow down is input to the program. The program is written in Algol for the Risø Burroughs B6700 computer. Plotter procedures are widely used to finish the output and lineprint output is minimized. The problem size, i.e., the number of nodes, is independent of the program, only determined by the user. The ratio process time/real time for a 500 node problem is 100:1. 11 references. (auth)

2135 QUALITY ASSURANCE TERMS AND DEFINITIONS. ANSI N45.2.10. New York; American Society of Mechanical Engineers (1972). 11p.

Nomenclature and definitions for the terms used in the field of quality assurance are given. (J.M.J.)

2136 NEW TENDENCIES IN NUCLEAR LAW. PERMANENT SEMINAR: EXCHANGE OF VIEWS OF NUCLEAR TECHNOLOGY. Pfaffelhuber, J. K. Energiewirt. Tagesfragen; 22: No. 5, 213-19(1972). (In German).

The following three groups of questions are discussed: (1) Questions relating to legislation: 1.1 Regional planning and site planning for nuclear power plants. 1.2 Should the licensing procedure for nuclear power plants in accordance with paragraph 7 of the Atomic Energy Law be replaced by an overall procedure summarizing the various applications to be submitted to the various federal and local authorities in one plan, to be examined and approved by only one licensing authority. 1.3 Can the licensing procedure be expedited by facilitating imposition of further conditions subsequent to the granting of a license. 1.4 Marking the Atomic Energy Law off from the regulations safeguarding the protection of air and water. 1.5 Ratification of the Paris Convention on Third Party Liability in the Field of Nuclear Energy and the additional Brussels Convention. 1.6 Necessary reforms of the present regulations relating to Radiation Protection in order to bring them in line with present-day standards in nuclear science and technology. (2) Questions pertaining to the execution of legal provisions: 2.1 The decision-taking process within the federal authorities and the tasks of the Federal Commission on Reactor Safety. 2.2 Technical and scientific principles governing the licensing of nuclear installations. 2.3 Improvements with regard to the time of inquiry (3) Organizational aspects: The Federal Authority for Reactor Safety and Radiation Protection. (Germany)

2137 CAUSE-CONSEQUENCE DIAGRAM METHOD AS A BASIS FOR QUANTITATIVE RELIABILITY ANALYSIS. Nielsen, D. S. (Danish Atomic Energy Commission, Roskilde). pp 2.1-13 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

A representation of a graphical method for clarifying relevant accidents in complex nuclear installations is presented. Generally expressed, the method is a proposal for an expedient presentation of the logical connections between a "spectrum" of accident causes and a "spectrum" of relevant consequences, e.g., expressed in terms of released fission products to the population. Besides being a tool used in connection with clarification of these consequences, the method serves as a basis from which the probability of occurrence of the individual consequences can be evaluated. Presented are the logical connections between essential foreseeable failure causes, failure courses and their consequences in both cases, terminated as intended, and not terminated as intended. As an accident is the result of a coincidence of events and/or failures, fault-trees with the logical "AND" and "OR" gates are used. 8 references. (auth)

2138 DESCRIPTION OF COMPONENT COMBINATIONS IN TECHNICAL SYSTEMS WITH THE AID OF THE FAULT-TREE METHOD. Balfanz, H.-P.; Ullrich, W. (Technische Ueberwachungs-Vereine eV, Cologne). pp 3.1-9 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

The problems of working out a model of reliability for a technical system are dealt with. The computation of the fault-tree by a fault-tree simulation computer program which is used in the IRS is touched upon only in the description of the examples to be presented. (auth)

2139 SURVEY AND CRITICAL ANALYSIS OF PROGRAMS FOR SYSTEM RELIABILITY COMPUTATION. Colombo, A. G.; Ricchena, R.; Volta, G. (CCR-EURATOM, Ispra, Italy). pp 4.1-10 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

The programs for system reliability computation reported in the literature are examined and grouped according to the methods applied. Either the methods describing the structure system by binary random variables or those that employ continuous random variables are considered. The main advantages and disadvantages of each method in relation to the specific problem to be solved are discussed. An example of application, of both a simulation code developed at CCR Ispra and of an analytical code, is given. The fault-tree considered is of mean-complexity, it describes the accident of a loss of three pumps in an in-pile loop. 15 references. (auth)

2140 REMO: A NEW CODE FOR SYSTEMS RELIABILITY ANALYSIS. Ricchena, Raffaele (EURATOM, Ispra, Italy). 8p. of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

The Remo program allows to make the most of the simulation method in the general case of the systems with repair and standby components. Furthermore it minimizes disadvantage typical of simulation that is the long and expensive computation time. By a suitable implementation it can be extended to the analytical search of the cut paths. The REMO program contains tricks and algorithms which allow maximum simulation of systems with both standby components and those which require immediate repair. High computer cost of reactor simulation is minimized. The program can be modified to analyze failures. (J.M.J.)

2141 MERITS OF THE SYSTEMATIC AND PROBABILISTIC APPROACH TO THE SAFETY OF NUCLEAR POWER PLANTS: SOME THOUGHTS; EXAMPLE OF APPLICATIONS. Prouillac, C.; Yvon, M. (Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France). 12p. of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971). (In French).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

2142 RELIABILITY ANALYSIS OF A PWR-EMERGENCY CORE COOLING SYSTEM. Hoertner, H.; Bastl, W. (Technische Hochschule Muenchen, Garching, Ger.). pp 12.1-11 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

Continuing the investigation of the emergency core cooling system of a PWR a more detailed analysis was done for that part of the system which is installed to cope with the double-ended rupture of a main coolant loop. The reliability of the system was calculated for the injection phase at the worst moment of accident in case of a hot leg rupture. The results of a precise analysis on the basis of the Monte Carlo Method are compared with block diagram calculations. In order to have a real possibility of comparison in the Monte Carlo calculations, no repairs were taken into account. The influence on reliability of such repairs really executed for revealed faults of components is finally shown. (auth)

2143 ENVIRONMENTAL ASPECTS OF ELECTRICITY PRODUCTION BY NUCLEAR POWER REACTORS. Davids, J. A. G.

Atoomenergie Haar Toepass.; 14: 221-7(1972). (In Dutch).
From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

The environmental aspects of nuclear power production are briefly described. Emphasis is given to those aspects of primary importance in the Netherlands. (auth) (Netherlands)

2144 SAFETY ASPECTS BY APPLICATION OF NUCLEAR POWER. van Daatselaar, C. J. Atoomenergie Haar Toepass.; 14: 227-32(1972). (In Dutch).
From Conference on nuclear energy; Petten, Netherlands (30 May 1972). See CONF-720555.

A n-th order risk is defined as one expected to cause the death of one in 10^n people per year. This concept is applied to nuclear energy and comparisons are made to other fields, e.g., dam failures in Holland. The justification of financial outlays to reduce nuclear hazards is discussed. (auth) (Netherlands)

2145 RADIATION SAFETY PROBLEMS IN THE OPERATION OF ATOMIC ELECTRIC POWER STATIONS. Arkhangel'skaya, I. G.; Baranov, M. A.; Beskrestnov, N. V.; (and others). Gig. Sanit.; No. 4, 59-63(Apr 1972). (In Russian).
The problems of radiation safety of both the personnel of atomic electric power stations (AEPS) and the population living in its vicinity are discussed. Investigations performed at the Novovoronezhskaya and Beloyarskaya AEPS showed the yearly average irradiation level of the personnel to be within 50% of the maximal permissible doses existing in the USSR. The pollution levels of the environment, such as the atmosphere, plants, water, etc., serve as a radiation background and are determined by the global falls. Experience of the first 15-year operation of AEPS in the USSR proves them to be quite safe in respect to irradiation of both the personnel of AEPS and the population of the neighboring territories. However, there still exist some unsolved problems in the construction of large AEPS in the vicinity or within the boundary of large towns. (auth)

2146 EARTHQUAKE RESPONSE ANALYSIS OF REACTOR STRUCTURES. Newmark, N. M. (Univ. of Illinois, Urbana). Nucl. Eng. Des.; 20: No. 2, 303-22(1972).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

The general nature of the principles upon which earthquake resistant design is based is described with particular reference to components and elements of nuclear reactor facilities. Special attention is paid to the response and design criteria of items of equipment or of components that are mounted on or attached to responding elements, and basic procedures are developed to bound the dynamic response of such items. Consideration is given to vertical as well as horizontal excitation, and to the combination of the effects of the various excitations. Suitable approximations are developed for inelastic response estimates. The relative motions of points some distance apart, and bounds for such relative motions are discussed in detail. Recommendations are made for the general criteria governing the design of nuclear facilities, including the basic parameters governing response characteristics and energy absorption. (auth)

2147 EVALUATION OF NUCLEAR SYSTEM REQUIREMENTS FOR ACCOMMODATING SEISMIC EFFECTS. Pickel, T. W. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.; 20: No. 2, 323-37(1972).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

An integrated approach is presented for the design of nuclear facilities to accommodate seismic effects. Site evaluation and soil-structure interaction are discussed briefly since they determine the magnitude and characteristics of the input forcing function to be used in the analysis. The evaluation of the requirements of the nuclear system to accommodate the effects of specified seismic input forces involves the classification of components of the system, development of a mathematical model which adequately defines and relates the components of the system, consideration of coupling and resonance effects on the interactions among the components, selection of the methods of analysis, and choice of the methods of solving the resulting equations. Specific design considerations and criteria for judging the acceptability of the design are discussed. (auth)

2148 PHILOSOPHY AND PRACTICE OF THE ASEISMIC DESIGN OF NUCLEAR POWER PLANTS: SUMMARY OF THE GUIDELINES IN JAPAN. Hisada, Toshihiko (Japan Electric Association, Tokyo); Akino, Kinji; Iwata, Tsuneo; (and others). Nucl. Eng. Des.; 20: No. 2, 339-70(1972).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

A guideline for aseismic design of nuclear power plants is summarized. The philosophy and criteria are described. All components of a plant are classified into three classes in accordance with their effects on reactor safety. Design to earthquake loadings should be based on "design basis earthquake" which is decided in consideration of local seismicity. Site selection and review for ground are described in the sense of seismic aspects. Deciding the earthquake motion for design is discussed. In Japan, semi-statistical approaches are used in normal practice. (auth)

2149 SEISMOLOGICAL PROBLEMS IN THE REACTOR FIELD. Costes, D. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Eng. Des.; 20: No. 2, 371-83(1972). (In French).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

A compendium of seismological problems and of earthquake engineering calculations in the nuclear energy field is presented with emphasis on French activity. The following topics are discussed: earthquake origin, wave propagation, reference earthquake for calculations, spectral analysis and resonance techniques, various mathematical earthquake models, soil-foundation interaction, structural responses, regulation. A quick look is given on earthquake calculations for the Phenix reactor primary system, with a very short algebraic earthquake. A main field in earthquake engineering for nuclear reactors is the choice of the larger intensity for which the reactor should remain safe. This problem is dominated by the hypothesis of a natural absolute limit, subject to discussion between seismologists. Taking account of lower limits in low-activity areas could mean a logical acceptance of some level of risk. This major point is mentioned only briefly. The technical means for designing earthquake-proof reactors are not presented. (auth)

2150 EARTHQUAKE RESPONSE ANALYSIS FOR A BWR NUCLEAR POWER PLANT USING RECORDED DATA. Muto, Kiyoshi (Muto Inst. of Structural Mechanics, Inc., Tokyo); Omatsuzawa. Nucl. Eng. Des.; 20: No. 2, 385-92(1972).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

In the dynamic analysis of complicated structures such as nuclear power plants, it is necessary to consider different damping characteristics for each structural element. A computer program for the dynamic analysis was developed based on the internal viscous damping theory, a vibration test was performed and earthquake observations of an actual nuclear power plant were made. The data resulting from the test and observation were applied to the program and the dynamic response of each part of the plant was computed. A close agreement was noted between the computed and recorded acceleration—time histories as well as acceleration—response spectra. It was concluded that the analyzing system might be one of the most reliable methods for the design of the nuclear power plants. (auth)

2151 ADVANCES IN THE ANALYSIS OF PRESTRESSED CONCRETE PRESSURE VESSELS. Lewis, D. J.; Irving, J.; Carmichael, G. D. T. (Central Electricity Generating Board, Berkeley, Eng.). Nucl. Eng. Des.; 20: No. 2, 543-73(1972).
From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.2).

Recent developments in the structural analysis of prestressed concrete pressure vessels are presented. Since the first concrete pressure vessels were designed, considerable advances have been made in the fields of elastic and thermal analysis. Typical applications of the finite element method to concrete vessels are shown and the correlation obtained with both site and experimental measurements discussed. Creep in concrete has been shown to be of importance due to the stress reversals which can occur on cooling. Correlations are shown between strain predictions and site measurements over the first five years of the life of the Oldbury vessels. The time increment type of creep analysis is shown to be valuable in the examination of detail problems. For example, the effect of standpipe reinforcement on the creep behavior of a top cap has been assessed. Such methods are however, expensive in computer time for the examination of a full non symmetrical vessel geometry. How viscoelastic collocation, and other techniques can be used to study creep behavior with a minimum of computation is shown. Finally, some criterion is required for assessment of the multiaxial stress states calculated by these advanced computer methods. A simple graphical method is shown, based on experimental results, which allows the rapid assessment of the acceptability of a multiaxial compressive stress state in concrete. (auth)

Steam and Power Conversion System

2152 TRANSIENT HEAT CALCULATIONS AS THE BASIS FOR STRESS ANALYSES OF STEAM GENERATORS AND HEAT EXCHANGERS. Fritz, K.; Jahn, F.; Lendl, H. (Waagner-Biro AG, Vienna). Nucl. Eng. Des.; 20: No. 1, 5-29(1972). (In German).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

The assessment and design of heat-transfer equipment is based on thermal calculations. For conventional components and in many cases also for nuclear applications this basis was restricted to the steady-state thermal performance, whereas for the transient behavior estimates derived from the experience with existing installations had to be used. The reason for this unsatisfactory state of the art was, that — although exact theoretical calculation models did exist — the actual performance of such calculations is cumbersome and time consuming. Results have been obtained only for simple cases or with simplified calculation models. Computer programs enabling an exact prediction of the transient behavior of steam generators were made available only recently. The Waagner-Biró computer codes TRANS were developed especially for the analysis of the dynamic (transient) behavior of once-through steam generators with any geometry and flow arrangement. Temperature, mass flow rate and pressure of both primary and secondary medium can be introduced as time dependent functions. Combinations of the above variables, simultaneously or consecutively, are possible. The results include time functions of temperature, mass flow rate and pressure of both media at any location in the steam generator. The codes can also be used for heat exchangers; no limitations exist concerning the type of the primary and secondary medium. Also for heat transfer between more than two media — with and without change of phases — the codes are applicable. The complexity of the heat and mass transport problems dealt with in the TRANS programs necessitated a limitation in the geometric barrier between primary and secondary medium. This barrier has been fixed to be a tube; its diameter, wall thickness and material can be selected independently for each section. More complicated geometries like headers and tube plates cannot be introduced into the program. Such components are of less or no importance for heat transfer calculations which are performed in the TRANS programs, but in general represent the most critical and determining parts from the point of view of stress analysis. Thus, separate codes, TRALIN and FINTRAN, have been elaborated by means of which temperature fields, both stationary and transient, for bodies of any geometric shape can be calculated. Thermal data are introduced as boundary conditions, e.g. time functions of local temperature and heat transfer coefficient of one or more media in contact with a specific face of the body; the geometry is represented by a fine subdivision of the structure, similar to the "finite-element" method in stress calculation. This has the advantage that the TRALIN/FINTRAN results can be used directly in finite element stress programs or that in a following program step the stress calculation can be performed directly on the basis of the transient temperature distribution at any given time. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstract 239.

2153 (ANCR-1077) GAMMA HEATING IN REFLECTOR HEAT SHIELD OF GAS CORE REACTOR. Lofthouse, J. H.; Kunze, J. F.; Young, T. E.; Young, R. C. (Aerojet Nuclear Co., Idaho Falls, Idaho). Aug 1972. Contract C-54558B. 33p. (NASA-CR-120903). Dep. NTIS.

Heating rate measurements made in a mock-up of a BeO heat shield for a gas core nuclear rocket engine yields results nominally a factor of two greater than calculated by two different methods. The disparity is thought to be caused by errors in neutron capture cross sections and gamma spectra from the low cross-section elements D, O, and Be. 17 references. (auth)

2154 (DOCKET-50238-93) N. S. SAVANNAH. Semiannual Operations Report, March 22, 1972-September 30, 1972. (Maritime Administration, Washington, D. C.). 3 Nov 1972. 3p. Dep. NTIS.

2155 (DOCKET-50238-94) N. S. SAVANNAH. Failure of Alarm Systems. (Maritime Administration, Washington, D. C.). 15 Sep 1972. 6p. Dep. NTIS.

2156 (LA-3128) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING JULY 20, 1964. (Los Alamos Scientific Lab., N. Mex.). Aug 1964. Contract W-7405-eng-36. 12p. Dep. NTIS.

Declassified 26 Oct 1972.

The fabrication and radiation testing of fuel pins for thermionic reactors are described. (D.C.C.)

2157 (LA-3195) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING OCTOBER 20, 1964. (Los Alamos Scientific Lab., N. Mex.). Nov 1964. Contract W-7405-eng-36. 13p. Dep. NTIS.

Declassified 26 Oct 1972.

The fabrication and radiation testing of fuel pins for thermionic reactors are described. (D.C.C.)

2158 (LA-3412) LECTURES ON NUCLEAR THERMIONIC ELECTRIC PROPULSION FOR SPACE. Salmi, Ernest W. (comp.) (Los Alamos Scientific Lab., N. Mex.). Jul 1965. Contract W-7405-eng-36. 251p. Dep. NTIS.

Declassified 26 Oct 1972.

A series of lectures on the status and immediate goals for development of thermionic nuclear electrical propulsion systems for spacecraft are presented. Included are lectures on thermionic cells, heat pipe space radiators, thrust motors, thermionic reactors, moving belt radiators, thermionic space radiators, shielding requirements, and interplanetary flight. (J.M.J.)

2159 (LA-3666(Pt.2)) QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING JANUARY 31, 1967. PART II. (Los Alamos Scientific Lab., N. Mex.). Feb 1967. Contract W-7405-eng-36. 7p. Dep. NTIS.

Declassified 26 Oct 1972.

The sensitivity of the power distribution profile in thermionic fuel rods (a series of thermionic cells) is described. The ability of Mo-UO_2 fuels to retain ^{85}Kr is discussed. Fission gas release measurements from W-UO_2 fuels were made at 1600°C. Fabrication methods for fuel pins for plasma thermocouples are outlined. 6 references. (J.M.J.)

2160 (LA-3709) QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING APRIL 30, 1967. PART II. (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 7p. Dep. NTIS.

Declassified 26 Oct 1972.

The feasibility of converting the Fast Reactor Core Test Facility to a thermionic reactor fuel element test facility was evaluated. It was found that it was not feasible to replace part of SNAP-8 core with thermionic fuel elements for production of small amounts of electricity. The use of heat pipes to cool thermionic reactors was considered favorably, an advantage being provided to reduce moving parts and thus increase system life and reliability. Parameters associated with the fabrication of Mo-UO_2 fuel pins were evaluated. Fabrication of Y_2O_3 and Al_2O_3 insulators is described. (J.M.J.)

2161 (LA-3942) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING APRIL 30, 1968. PART II. (Los Alamos Scientific Lab., N. Mex.). 24 May 1968. Contract W-7405-eng-36. 14p. Dep. NTIS.

Declassified 26 Oct 1972.

Size and configuration of thermionic reactor fuel pins are discussed. Core physics calculations for a thermionic reactor are presented tabularly. Measurements of fission gases retained in irradiated fuel pins were made. Methods for the fabrication of W-clad, Mo-UO_2 and Mo-coated, Mo-UO_2 cermet fuel pins are described. Performance of graded seals of bonded Al_2O_3-Nb composite was tested at 1530°C and 15000 psi. (J.M.J.)

2162 (LA-4110) QUARTERLY STATUS REPORT ON SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1969. PART II. (Los Alamos Scientific Lab., N. Mex.). 26 Feb 1969. Contract W-7405-eng-36. 24p. Dep. NTIS.

Declassified 26 Oct 1972.

A thermionic reactor, partially loaded with thermionic fuel rods, is described. Burnup data are given for irradiated 10% enriched Mo 40 v/o UO_2 cermet fuel pins. ^{85}Kr and ^{137}Cs releases from fuel pins of the above composition were measured. Fabrication parameters and physical properties of Mo-UO_2 fuel pins are described. Fabrication methods and physical properties of 3-layer laminates of Nb-Lucalox-Nb and Nb-1% Zr-Lucalox-Nb-1% Zr are discussed. (J.M.J)

2163 (LA-4183) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING APRIL 30, 1969. (Los Alamos Scientific Lab., N. Mex.). 28 May 1969. Contract W-7405-eng-36. 22p. Dep. NTIS.

Declassified 26 Oct 1972.

The difference in reactivity between the unperturbed SNAPTRAN Reactor and the reactor with an experimental assembly in the center fuel-rod position was measured. Creep data for tungsten is presented graphically. Studies were made on the cause of cracking of Nb-Lucalex-Nb trilayer bonded insulator while undergoing temperature testing. Results of in-pile radiation testing of Lucalex, Al-995, AD-995, and Y_2O_3 ceramic electric insulators are presented. A method for diffusion bonding niobium to aluminum oxide is described. (J.M.J.)

2164 (LA-4232) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JULY 31, 1969. (Los Alamos Scientific Lab., N. Mex.). 21 Aug 1969. Contract W-7405-eng-36. 19p. Dep. NTIS.

Declassified 26 Oct 1972.

Fast neutron radiation effects on Al_2O_3 insulating materials in the core of a thermionic reactor were calculated. Methods for control of zirconium hydride moderated thermionic reactors are discussed. Fabrication methods for Mo-UO_2 fuel pins are described. A method for fabrication of a stress free trilayer bonded laminate of niobium-Lucalex-niobium, and the physical properties of the product are given. Methods for determination of fast and thermal neutron fluence in EBR-2 are given. (J.M.J.)

2165 (LAMS-2704) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING MARCH 20, 1962. (Los Alamos Scientific Lab., N. Mex.). Apr 1962. Contract W-7405-eng-36. 8p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2166 (LAMS-2741) STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR FOUR-MONTH PERIOD ENDING JULY 20, 1962. (Los Alamos Scientific Lab., N. Mex.). Aug 1962. Contract W-7405-eng-36. 15p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2167 (LAMS-2852) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING JANUARY 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Feb 1963. Contract W-7405-eng-36. 10p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2168 (LAMS-2905) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING APRIL 20, 1963. (Los Alamos Scientific Lab., N. Mex.). May 1963. Contract W-7405-eng-36. 12p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2169 (LAMS-2951) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING JULY 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Aug 1963. Contract W-7405-eng-36. 11p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2170 (LAMS-3000) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING OCTOBER 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Nov 1963. Contract W-7405-eng-36. 14p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2171 (LAMS-3042) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING JANUARY 20, 1964. (Los Alamos Scientific Lab., N. Mex.). Feb 1964. Contract W-7405-eng-36. 12p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2172 (LAMS-3084) QUARTERLY STATUS REPORT OF THE LASL PLASMA THERMOCOUPLE DEVELOPMENT PROGRAM FOR PERIOD ENDING APRIL 20, 1964. (Los Alamos Scientific Lab., N. Mex.). May 1964. Contract W-7405-eng-36. 14p. Dep. NTIS.

Declassified 26 Oct 1972.

Information is presented concerning the fabrication and radiation testing of fuel pins for thermionic reactors. (D.C.C.)

2173 CNSG: AN ADVANCED PWR. Dickinson, R. W. (Babcock and Wilcox, Lynchburg, Va.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 2-3(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

Process Heat and Desalination Reactors

Refer also to abstract 713.

2174 (CONF-710444-8) UTILIZATION OF NUCLEAR ENERGY FOR THE PRODUCTION OF STEAM AND CURRENT IN A LARGE CHEMICAL COMPLEX. Frank, B. (Badische Anilin- und Soda-Fabrik A G., Ludwigshafen am Rhein (West Germany)). 1971. 29p. (In French). Dep. NTIS (U. S. Sales Only).

From International conference on chemical sciences; Paris, France (20 Apr 1971).

The Badische Anilin- und Soda Fabrik AG industry, whose steam requirements reach between 2000 and 2500 t/h, and whose electrical power requirements reach 700MW, has the capacity to utilize throughout the year the output of a 2000MW thermal reactor. A nuclear power plant supplying the steam required must be sited at the center of the production factory. Very stringent safety measures are thus necessary. The installation of such a reactor is envisaged in 1972. (auth)

2175 (JUL-842-RG) MODEL STUDIES ON COSTS AND ECONOMICS OF POSSIBLE COMBINATIONS OF INDUSTRIAL PLANTS WITH HIGH-TEMPERATURE REACTORS AS ENERGY SOURCES. Schwegmann, Peter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Apr 1972. 125p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

An analysis is presented of the economics of industrial plants using the HTR as the energy source. The plants considered include plants producing synthesis gas by steam cracking methane, hydro-cracking of heavy oils and coal gasification in combination with processes making use of synthesis gas such as production of ammonia, methanol and iron ore direct reduction; petrochemical plants producing ethylene, propylene etc., by cracking naphtha; and steam generation and production of electricity. Investment, capital costs and operating costs of typical combination plants with HTR's in the size range 500 to 3000 MW thermal were studied for the purpose of quantitatively determining the return of investment for these plants. 88 references. (auth)

2176 (ORNL-NDIC-11(Rev.1)) TITLE-AUTHOR-COMPANY INDEX TO REPORTS PUBLISHED BY THE U. S. DEPARTMENT OF THE INTERIOR OFFICE OF SALINE WATER THROUGH JULY 1972. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-Eng-26. 109p. Dep. NTIS.

A permuted index of the titles, authors, companies, and numbers of approximately 800 research and development progress reports issued by the Office of Saline Water, U.S. Department of the Interior through July 1972 is given. The index was prepared with the aid of a computer and is presented in the form of computer printout. (auth)

2177 (RT/ING-(72)3) THERMAL DESIGN OF THE SHIELDING OF CONTROL SYSTEMS AND STUDY OF SAFETY FOR REFUELING SYSTEM IN DESALINATION REACTORS. Cesari, F.; Dessolis, F.; Stampone, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Jan 1972. 288p. (In Italian). Dep. NTIS (U. S. Sales Only).

The refueling systems for various power reactors are briefly examined. The mechanical design of the fuel handling system of the ROVI reactor is first described. The design of control and safety systems, the operational examination of the refueling operation, verification of the shielding, analysis of the various cooling conditions on the fuel element, and the preliminary safety analysis are then considered. (tr-auth)

2178 APPLICATIONS OF HTGRs TO CRITICAL ENERGY NEEDS IN THE USA. Melese-d'Hospital, G. (Gulf General

Atomic, San Diego, Calif.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 21(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

Research and Test Reactors

Refer also to abstracts 184, 403, 1927, and 2216.

2179 (AECL-3797) RADIATION DOSIMETRY IN WR-1 REACTOR. PART III. DETERMINATION OF FLUX DENSITY. Mehta, K. K.; Stadnyk, A. M. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Mar 1972. 30p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Fast, thermal and epithermal flux densities were determined at various irradiation locations in the WR-1 reactor. These values agreed with those calculated by the computer codes NEVEMOR and LATREP, thus verifying the two codes. The value of the thermal flux density in the pneumatic capsule facility is compared with that computed from the self-powered detector located there. 11 references. (auth)

2180 (AECL-4212) SLOWPOKE AT THE UNIVERSITY OF TORONTO: A LABORATORY REACTOR FOR NEUTRON IRRADIATION. Hilborn, J. W.; Kay, R. E.; Stevens-Guille, P. D.; Jervis, R. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1972. 41p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

SLOWPOKE is a new type of reactor developed by Atomic Energy of Canada Limited for use by universities, hospitals and research institutes. It is a safe, reliable, low-cost source of neutrons for isotope production and neutron activation analysis. The prototype reactor, built and tested at Chalk River Nuclear Laboratories, was subsequently dismantled and installed at the University of Toronto, where it has successfully completed its first year of operation. This reactor has a number of novel features including low critical mass, inherent safety, and unattended operation. Irradiation facilities allow samples to be irradiated in a thermal neutron flux up to 2.6×10^{11} n/cm^2.s at a reactor power of 5 kW. A summary of the first year's operation shows the high availability of the reactor and its increasing use within the University. An outline is given of future plans to uprate the thermal flux to 1×10^{12} n/cm^2.s, and extend the period of unattended operation to 18 hours.

2181 (ANL-7910, pp 337-426) EXPERIMENTAL TECHNIQUES AND FACILITIES. Jan 1972.

In Applied Physics Division annual report, July 1, 1970 to June 30, 1971.

Measured integral reactor physics parameters are necessary for either direct introduction into reactor design calculations or for comparison with values obtained analytically using basic microscopic cross section data. In the latter case the objective is to verify either the cross section data or the calculational techniques. Reactor integral parameters are obtained using special measurement techniques in exponential or critical facilities. The papers presented deal largely with the development of such special techniques, facilities, and radiation detection devices. Included also are papers which describe specially developed equipment useful in obtaining microscopic nuclear data. (auth)

2182 (DOCKET-50139-1) UNIVERSITY OF WASHINGTON NUCLEAR REACTOR. Plutonium Contamination Incident of June 13, 1972. (Washington Univ., Seattle (USA). Nuclear Reactor Labs.). 25 Oct 1972. 80p. Dep. NTIS.

2183 (LA-4926) STATUS OF WORK RELATED TO THE KING REACTOR AS OF MARCH 1972. King, L. D. P. (comp.) (Los Alamos Scientific Lab., N. Mex.). Aug 1972. Contract W-7405-eng-36. 124p. Dep. NTIS.

Past and present work aimed at developing and constructing an advanced high intensity fission neutron facility using the Kinetic Intense Neutron Generator or KING Reactor concept is summarized. Some of the promising features of this concept are first briefly described and referenced to existing reports. Then the results of a preliminary study and cost estimate for constructing a 25 MW KING Reactor at Los Alamos are presented. Finally the status of work and experiments related to the understanding and design of such a reactor system which are now in progress are summarized. 39 references. (auth)

2184 (ORNL-TM-3679(Vol.1)) REACTOR ON-LINE COMPUTER CONTROL DEVELOPMENT AT THE HFIR. VOL. 1. OBJECTIVES, SYSTEM DESIGN, OPERATING EXPERIENCE, AND SAFETY CONSIDERATIONS. Bullock, J. B.; Danforth, H. P. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 208p. Dep. NTIS.

Methods of utilizing process computers in the control and operation of nuclear reactors were evaluated. The ability of an on-line digital system in calculating core reactivity balance for use in automatic control algorithms and for core anomaly detection was demonstrated by installing, programming, and operating an on-line digital computer at the HFIR. The development of operator assistance functions revealed additional assets of programmable systems, particularly in data reduction, extrapolating operating conditions, and alarm analysis. From safety considerations concerning the use of the computer in manipulating control rods, we conclude that no additional hazards are encountered when the normally required independent safety systems are provided. (17 references) (auth)

2185 (PEL-221) DERIVATION OF SAFE CONTINUOUS RELEASES OF AIRBORNE RADIOACTIVITY FROM THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. van As, D.; Vleggaar, C. M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1972. 16p. Dep. NTIS (U. S. Sales Only).

The original permissible release of airborne radioactivity for normal reactor operating conditions from the 70m high stack at Pelindaba was calculated without meteorological, dispersion or reconcentration data for the site being available at that stage. Since 1968, however, data concerning wind speed, wind direction and the vertical temperature profile were continuously recorded on site and were used to compute the expected incidence of three categories of atmospheric stability in each of eight directional sectors around the site. Experimental determinations of atmospheric dispersion were made for each of these stability categories. The expected incidence of the different stability categories in each direction and the accompanying dispersion data were used to determine the resultant dilution of continuous releases for each sector. The distances at which uniform dispersion is expected to prevail in each sector were calculated and contours of expected equidilution were mapped. This information can be utilized in the planning of the future development of this area. Safe levels of radioactivity in air and milk were calculated and the permissible annual releases of certain critical nuclides, i.e., ^{131}I, ^{90}Sr and ^{137}Cs, to the atmosphere were derived for the measured parameters of the site. (10 references) (auth)

2186 (SC-RR-720256) ANALYTICAL MODEL AND CALCULATIONS OF HYPOTHETICAL LOSS-OF-COOLANT ACCIDENT. Rivard, Joseph B. (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 45p. Dep. NTIS.

An analytical model and calculations are presented for the hypothetical loss-of-coolant from the Annular Core Pulse Reactor (ACPR). Coupled Volterra equations are derived which describe air cooling of the hot channel of ACPR following reactor shutdown and loss of water coolant. The resulting envelopes of calculated maximum fuel temperatures are varied by choice of parameters and initial conditions. (3 references) (auth)

2187 (SC-RR-720301) ANNULAR CORE PULSE REACTOR (ACPR) COOLANT CHANNEL CALCULATIONS AND EXPERIMENTS. Estes, B. F.; Rivard, J. B. (Sandia Labs., Albuquerque, N. Mex.). Jul 1972. 42p. Dep. NTIS.

The exact solution of a one-dimensional analog of a reactor coolant channel under steady-state conditions is given. An analytical approximation for the fuel centerline temperature is also found. Experiments in support of the calculations have been made of the temperature increase of the coolant traversing the ACPR core. Temperature profiles derived from the calculations are given. 6 references. (auth)

2188 (SC-RR-720605) ANNULAR CORE PULSE REACTOR (ACPR). 153 AND 159 FUEL ELEMENT CORE LOADINGS. Conant, J. C.; Estes, B. F.; Huston, J. E.; Morris, F. M.; Rivard, J. B.; Thome, F. V. (Sandia Labs., Albuquerque, N. Mex.). Aug 1972. 22p. Dep. NTIS.

Two core loading experiments giving increased excess reactivity over the present operating excess of about $8.00 are described. Incremental worths of the fuel elements were determined by both the positive period and static methods. Flux tilting was prevented by the exclusive use of the control rod bank in the period method. (auth)

2189 STATUS OF THE FFTF PROJECT. Jacobi, W. M.; Weber, S. A. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 15: Suppl. No. 2, 10-11(1972).

From Conference on nuclear power for tomorrow; Atlantic City, NJ. (22 Aug 1972). See CONF-720817.

2190 OPERATIONAL RELIABILITY EVALUATION OF AN IN-PILE LOOP. Colombo, A. G. (CCR, Ispra, Italy); Luisi, T.; Volta, G.; Proja, E. pp 13.1-10 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation

to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

Experience during the last two years with a reliability program applied to the loop CART operating in the Essor reactor is reported. Modifications and improvements of the original codification, data collection and data analysis procedures are presented and discussed in the light of the practical experience. The use of the collected data for the evaluation of the operational failure probability of a major accident (pump-loss) is described. The operational probability is calculated, using a bayesian technique. Given the fault tree and an assumed probability based on some prior (assumed) distributions, the distributions will be iteratively corrected using the information obtained during operation. 6 references. (auth)

2191 RELIABILITY ASSESSMENT OF A COMPLEX SAFETY SYSTEM WITH AUTOMATIC TEST. Tenaglia, G.; Valeri, A. (CNEN, Rome). pp 14.1-16 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

Studies on the reliability assessment of the automatic shutdown circuits of a research reactor are presented. The theoretical calculations have given a rather low figure of failure probability, so that the contribution of a few practical factors, which influence reliability but are difficult to evaluate, is predominant compared with calculated probability. Practical considerations have permitted a judgement on the adequacy of the examined circuits compared to the safety requirements. Theoretical calculations have allowed the evaluation of the amount of the advantage obtained with the installation of the test system in comparison to the circuits without test system. (auth)

2192 COMPARISON OF SOME EXPERIMENTAL RESULTS WITH CALCULATIONS FOR ZERO POWER REACTORS. Szatmary, Z.; Volko, J. (Central Research Inst. for Physics, Budapest). Kernenergie; 15: No. 3, 78-81(Mar 1972).

The reactor physics model developed in the Central Research Institute for Physics, Budapest, is applied to interpret experiments on the ZR-2, ZR-3, and ZR-4 reactors. Calculations carried out so far concern criticality, micro- and macroflux distributions. 9 references. (auth)

2193 DEVELOPMENT OF LOGIC CONTROL SYSTEMS FOR NUCLEAR REACTORS IN THE CENTRAL RESEARCH INSTITUTE FOR PHYSICS. Bollok, L.; Erdoes, P.; Zobor, E. (Central Research Inst. for Physics, Budapest). Kernenergie; 15: No. 2, 48-53(Feb 1972). (In German).

In the first reactors the reactor control system, i.e., the circuits to realize safety, operational, and interlock functions, were designed on the basis of a logic relay system. The wired programs of this relay system process the data obtained from nuclear and technological measuring channels with strict respect of safety and technological regulations. In designing the circuits efforts were made to fulfil the fail-safe principle. A qualitative improvement was obtained by the use of systems consisting of transistorized logic modular units, in which continuous information about the readiness for service of the circuits essential for safety is given by a periodically operated self-checking system. 9 references. (auth)

2194 CRYOGENIC IRRADIATION FACILITY IN THE SAFARI-1 REACTOR. Isebeck, K. (Atomic Energy Board, Pretoria). Radiat. Eff.; 14: No. 3-4, 143-55(Jun 1972).

A liquid helium cooled irradiation facility has been built and tested in the SAFARI-1 reactor (ORR-type). The distinguishing feature of this facility is the low refrigerative capacity at 4.4°K of only about 30 W coupled to a reactor of relatively high power (20 MW) and γ-heat (10 W/g). The γ-heat was reduced by placing a lead shield of 10 cm thickness against the pool-side experimental facility of the reactor. This reduces the γ-heat to about 0.1 W/g. A fast neutron facility can be established by surrounding the in-pile trunk with boral (flux 8×10^{12}n $cm^{-2}s^{-1}$, E > 0.1 MeV). For irradiations in a thermal neutron spectrum, a heavy water tank can be inserted between the in-pile trunk and the reactor face (flux 6×10^{12}n $cm^{-2}s^{-1}$, thermal). The ratio of fast to thermal flux can be changed by a factor of 10^4. An annealing facility for the application of square temperature pulses with a stability of 10^{-2}°K has been built as an integral part of the irradiation facility. (auth)

Production Reactors

2195 (TID-26134) BACKGROUND INFORMATION, DESCRIPTIONS, AND REPRESENTATIVE SAMPLES: SAVANNAH RIVER PLANT ADMINISTRATIVE CONTROLS. List, J. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Jan 1972. 550p. Dep. NTIS.

A compilation of documents from various sources, intended to describe the administrative control system applied to the operation of the Savannah River reactors and give examples of some of the more important control documents, is presented. Emphasis has been placed on the controls for safe operation within prescribed limits; some information on the development of the limits is included but no examples of the documentation involved are given. In general, such documents are classified. Documents describing the plant, giving background information, describing the Quality Assurance Program for Design, and the procedure used for initial checkout and testing are included in Appendices. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 253, 254, 301, 612, 616, 619, 628, 681, 683, 720, 725, 756, 764, 765, 803, 846, 849, and 857.

2196 (RDT-STATUS-9-72) RDT STANDARDS SUMMARY. Bimonthly Status Report as of September 29, 1972. (Division of Reactor Development and Technology (AEC), Washington, D. C.). 20 Oct 1972. 49p. RSO.

A status report of RDT Standards for the period ending September 29, 1972, which includes RDT standards for Responsible Standards Offices at HEDL, LMEC, and ORNL is presented. (auth)

2197 (SGAE-2031) TECHNICAL SAFETY ASPECTS OF THE REACTOR PRESSURE VESSEL. Schlosser, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Aug 1972. 29p. (In German). Dep. NTIS (U. S. Sales Only).

Reactor pressure vessels are discussed with respect to design and calculation, thermo-hydraulic analysis, stress analysis, creep behavior, and defect analysis. Also discussed are raw materials and fabrication. Under testing are treated preliminary testing, fabrication monitoring, end product examination, and periodic testing. With respect to continuously operating monitoring systems, acoustic methods as well as leak recognition methods are discussed. (H.B.G.)

2198 EXPERIMENTAL INVESTIGATION OF IN-REACTOR MOLTEN FUEL PERFORMANCE. Lepscky, C. (Comitato Nazionale Energia Nucleare, Rome); Testa, G. M.; Hougaard, H.; Jones, K. W. Nucl. Technol.; 16: No. 3, 367-95(Nov 1972).

Two instrumented fuel assemblies, containing Zircaloy-clad UO_2 fuel, namely IFA-132 (pellet, 95% T.D., 10.0 wt % ^{235}U) and IFA-133 (vibrocompacted powder, 85% T.D., 10.0 wt % ^{235}U) were irradiated in the Halden Boiling Water Reactor (HBWR) in Norway, in order to investigate the performance of fuel pins under central melting conditions. The maximum linear heat generation rate (LHGR) was about 1400 W/cm and the final burn-up was 11,000 MWD/MTU. The initial molten zone covered about 35% and 65% of the fuel radius for the pelleted and vibrocompacted fuel, respectively. By means of the in-pile instrumentation, the dimensional changes vs. generated power were recording during irradiation. Furthermore through extensive post-irradiation examinations the in-pile behavior of fuel and cladding was evaluated. In spite of incipient burn-out conditions, contact of molten or plastic fuel with the cladding, and localized overheating up to 900°C, the overall behavior gave no indication that irradiation to a higher burnup could not proceed satisfactorily. On the basis of the experiment, it seems justified to assume that central fuel melting should not be considered as a primary constraint in the fuel design criteria. 29 references. (auth)

2199 CONSIDERATIONS IN THE USE OF SYSTEM RELIABILITY MODELS. Bourne, A. J. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 1.1-8 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

The purpose of a system reliability model is to provide a mathematical tool for evaluating the reliability of a system

to some required degree of accuracy. In common with all mathematical models, a reliability model is only a representation of the actual situation. As such, the accuracy of the results it produces can generally be improved by increasing the degree of complexity and sophistication of the model. For any model there is a need to define the characteristics, the conditions of operation and the required functional performance of the system to which it is to apply. The reliability problem for the system then arises because the likely variations in the achieved performance of the system may take it outside the required limits. If the variations in system performance can be represented by statistical variates, then the system reliability is simply the probability of the achieved performance meeting the required performance under the relevant conditions of space and time. 5 references. (auth)

2200 PRINCIPAL RELIABILITY CONSIDERATIONS OF SAFETY SYSTEMS (LIMITS BY COMMON MODE FAILURES; INFLUENCE OF RELIABILITY OF THE SAFETY SYSTEM ON THE PLANT AVAILABILITY). Burger, H. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). pp 5.1-9 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

Safety systems are nearly always stand-by systems for use at any time during the plant's service life. Since the moment when such systems are needed is unknown, the reliability at the end of test intervals is not really of interest, but the average of a period containing several test intervals governs. 4 references. (auth)

2201 SOME BASIC ASPECTS OF PRACTICAL RELIABILITY ANALYSIS. Dressler, E. (Technische Hochschule Muenchen, Garching, Ger.). pp 6.1-10 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

The reliability of a small system, which works in several phases, and can only be calculated exactly with some difficulty, will be compared with calculations of the same system, simplified. The error obtained by the simplification will be estimated in advance. Difficulties caused by common mode failures can be overcome either by simplifying these systems or by using the Monte Carlo Method. Some pros and cons of both methods are shown, especially their applicability in computer codes. The higher fault probability of a system depending on the common mode failure will be computed. (auth)

2202 CAN TESTS ON SMALL SAMPLES JUSTIFY HIGH SYSTEM RELIABILITY? Nichols, P. (Central Electricity Generating Board, London). pp 7.1-12 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

Two assessment methods are considered. The confidence limit approach emphasizes the need to guard against optimistic unrepresentative test results, and in consequence tends to overestimate the true failure rate. The inverse probability approach, based on Bayes' theorem, allows for the possibility of either optimistic or pessimistic test results. The advantage of increased testing relative to each method is examined. Some indication is given of the anomalies that can arise if the rules for combining "absolute" probabilities in redundant systems are applied indiscriminatingly to probabilities estimated from limited test data. (auth)

2203 STATISTICAL INFERENCE FROM SMALL SAMPLES. SOME EXPERIENCE IN MECHANICAL RELIABILITY EVALUATION. Amesz, J. (EURATOM-CCR, Ispra, Italy). pp 8.1-19 of Proceedings of the CREST Specialist Meeting on Applicability of Quantitative Reliability Analysis of Complex Systems and Nuclear Plants in Its Relation to Safety. Garching, Ger.; Technische Universitaet Muenchen (1971).

From Conference on reliability analysis of complex systems and nuclear plants; Munich, Germany (26 May 1971). See MRR-90; CONF-710556.

With reference to the practical problem encountered in testing and evaluating graphite as a construction material for fuel elements, the approaches chosen in handling small sample of data (10 ÷ 50), many parameters (e.g., volume, surface, state of stress, density, batch production, environment, etc.), and specimens which are treated as models of a structure for which a "modelling law" is needed, are described. With regard to the basic statistical analysis of the distribution of data, parametric, non parametric and probability methods are applied. To give practical significance to the statistical analysis, both the need for sensitivity analysis of all "possible parameters and for hypothesis on a stochastic model of the failure mechanisms are shown. 3 references. (auth)

2204 FUEL CANS AND RIBBED PIPES FOR HEAVY-DUTY HEAT-EXCHANGERS. Enke, C. G. Baender, Bleche, Rohre; 13: No. 5, 239-41(1972). (In German).

Fuel cans for the fuel elements of nuclear reactors must meet extreme demands in respect of heat-resistance, structure, anticorrosion properties, dimensional accuracy and perfect workmanship. Only the most sophisticated plants can be used for their fabrication (rolling, surface treatment, straightening and testing). This also applies to the ribbed pipes used for heavy-duty heat-exchangers which greatly influence the geometrical layout and thermodynamical concept of these plants. (Germany)

2205 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. TECHNOLOGY, POWER REACTOR DEVELOPMENT METHODS OF STRUCTURAL ANALYSIS. First International Conference, Berlin, Germany, September 20-24, 1971. Nucl. Eng. Des.; 19: No. 1, 1-206(1972). (CONF-710903-(Vol.19,No.1)).

Fifteen papers were presented at the conference and are included in this issue. A separate abstract was prepared for each of 12. Three papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 251, 1944-1946, 1995, 1996, 2018, 2019, and 2206-2209.

2206 SIGNIFICANCE OF APPLIED MECHANICS IN DESIGNING THE FAST TEST REACTOR. Waymire, G. R. (WADCO Crop., Richland, Wash.). Contract AT(45-1)-2170. Nucl. Eng. Des.; 19: No. 1, 119-38(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The discipline of applied-mechanics analysis has had a significant influence in designing the Fast Test Reactor (FTR). The FTR is a sodium-cooled fast flux reactor being constructed to test candidate materials and fuels for the U. S. Liquid Metal Fast Breeder Reactor (LMFBR) program. The influence of applied mechanics is more evident in the design of a liquid metal cooled reactor such as the FTR than it is in the more conventional water-cooled designs, primarily because the combination of environmental conditions in a liquid metal reactor results in an interplay between the mechanics analyst and the reactor designer never before required. Specifically, these environments include a fast neutron spectra, high neutron fluence (flux-time) exposures, an elevated thermal environment, and a high conductivity coolant. The fast neutron spectrum (65% > 0.1 MeV) and high flux exposures (>10^{23} nv), when coupled with the thermal environment (1100°F in the active core), causes a metal growth phenomenon and a radiation-induced creep effect, particularly in the active core region. The high flux and fast spectra also cause metal embrittlement which must be factored into the elastic design of the more permanent, nonremovable structure within the reactor. The combination of an elevated temperature, a high conductivity coolant (sodium) and (in the case of the FTR) the diverse structures required in a test reactor, creates unique thermal stress conditions not previously encountered in water reactors. Criteria presently being used for structural design include residual ductility requirements for permanent structures; strain-limited design requirements for removable, highly irradiated components (such as the cladding); and an intermediate combined criteria for such items as the in-core component ducts. Areas where the analysis design interplay are particularly required include: duct and core restraint design and duct distortion/dilation analysis; inlet tube-sheet elastic design and neutron embrittlement considerations; and outlet instrumentation structures and thermal stress analysis of these structures under postulated transient conditions. The significant effect of these phenomena on reactor design is discussed, the analytic methods being used to formulate design solutions are described, and the resultant unique FTR features evolving from the analysis/design iterations are presented. (auth)

2207 LINEAR METHODS OF STRUCTURAL ANALYSIS. Argyris, J. H.; Buck, K. E.; Scharpf, D. W.; William, K. J. (Univ., Stuttgart). Nucl. Eng. Des.; 19: No. 1, 139-67(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The foundations of the finite element methods and their connection to alternative numerical procedures for linear structural problems are outlined. The state-of-the art of the finite element displacement method in structural mechanics is surveyed. Extension of the method to dynamic structural problems, to initial instability problems of thin plates and shells, to linear fracture mechanics, and to linear thermoelasticity is indicated. Examples representative of structural problems in reactor technology are included. (auth)

2208 NON-LINEAR METHODS OF STRUCTURAL ANALYSIS. Argyris, J. H.; Buck, K. E.; Scharpf, D. W.; William, K. J. (Univ., Stuttgart). Nucl. Eng. Des.; 19: No. 1, 169-97(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The foundations for the solution of physically nonlinear problems in structural mechanics are reviewed. Both aspects, the mathematical characterization of the nonlinear behavior and the numerical solution within the frame of the finite element method are discussed. A number of examples are presented which are relevant to problems of reactor technology. In particular problems of nonlinear elasticity, viscoelasticity, creep and elasto-plasticity are dealt with. (auth)

2209 APPLICATIONS OF SIMILITUDE TO THE STRUCTURAL MECHANICS OF REACTORS. Murphy, Glenn (Iowa State Univ., Ames). Nucl. Eng. Des.; 19: No. 1, 199-206(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.19,No.1).

The structural mechanics of a reactor involves the prediction of the behavior of the components of the reactor and the entire reactor system under a combination of gravitational and other force fields, electrical and magnetic fields, thermal fields and radiation fields. The nature of the materials and components is such that under the operational conditions imposed, the behavior is often nonlinear, with the result that the application of the usual techniques of mathematical analysis to predict behavior often results in lengthy computations based on assumptions that are somewhat subjective. Although computer techniques have proven very helpful in many instances, they are often limited in scope through size of available computer storage. The direct approach, that of cut-and-try design, is often not appropriate because of the possibility of release of radioactive materials in the event of a faulty design or a failure of the containment or other materials. In addition, economics, as well as safety, usually precludes construction of a complete operating unit without preliminary analysis. Under these conditions of complex mathematical analysis and expensive construction the use of small scale models is suggested as a method of obtaining data from which realistic predictions may be made. In the design of small scale models the theory of similitude is used in the same way that it has been used in many fields of engineering. It is also pertinent to consider current power reactors in the 400-MW range as models of projected reactors in the 2000-MW range. Direct application of the principles of similitude leads to a series of design conditions that cannot be satisfied simultaneously. In such a situation the application of distorted model theory is mandatory. The application of distorted model theory requires the determination of the prediction factors associated with the pertinent distortion factors derived from the significant parameters that are distorted. Evaluation of the prediction factors as functions of the distortion factors may be accomplished experimentally or analytically, and the remainder of the presentation is devoted to consideration of the applicable methods and procedures for determining the prediction factors. The analytical procedures may be classed as those based on well established laws and those based on fundamental principles. Specific illustrations of the application of the principles includes fuel element containment, distortion of primary containment, performance of containment shells as a result of sudden release of energy within or from external disturbances, and thermal strains resulting from loss of coolant and subsequent sudden cooling. As the numerical examples will illustrate, distorted model theory often enables one to make practical judgments concerning which distortions are significant and which will have a trivial influence upon the results. (auth)

2210 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. SHELL STRUCTURES; FRACTURE MECHANICS. First International Conference, Berlin, Germany, September 20-24, 1971. Nucl. Eng. Des.; 20: No. 1, 1-302(1972). (In German and English). (CONF-710903-(Vol.20,No.1)).

Fourteen papers were presented at the conference and are included in this issue. A separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 252–256, 675, 803, 857, 1991, 2152, and 2211–2214.

2211 THERMAL AND MECHANICAL STRESSES IN NUCLEAR REACTOR VESSELS. Hoffman, Roger E.; Ariman, Teoman (Univ. of Notre Dame, Ind.). Nucl. Eng. Des.; 20: No. 1, 31-55(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

A stress and deformation analysis is presented of a circular cylindrical, thin, elastic shell, representing a nuclear reactor vessel, with an insulated cutout of arbitrary shape subjected to mechanical and thermal loads. The analysis is based on the method of superposition. The actual stresses in the shell may be considered as the sum of the following two parts: stresses caused by the given heat flow and mechanical loads in a similar shell without a hole (nominal stress solution); and stresses in the shell caused by edge loads at the boundary of the hole (residual stress solution). The governing equations of this problem are the so-called Morley equations, which have nearly the same simple form as the well-known Donnell equations but include no other assumptions than those of the linear thin-shell theory. The mechanical loading consists of any loading normal to the shell surface. The thermal loading is represented by the middle surface temperature distribution and by specified temperatures on the inner and outer surfaces of the shell. The middle surface temperature distribution is determined by taking into account the temperature boundary conditions at both ends of the shell and the hole geometry. It should be mentioned that cutout causes the disturbance in the heat flow and therefore middle surface temperature distribution differs considerably from the no-hole case. The arbitrary hole is represented either by a polynomial of up to the tenth power in the shell coordinates, or it is specified point by point in the shell coordinates along with the value of the curve tangent at those points. The nominal stress solution is obtained in Fourier-series form from the Morley's equations. The method of point matching in the sense of least squares is used to obtain the middle surface temperature distribution and the residual stress solution. Thus a very general computer program, based on the explained formulation has been developed. This program is capable of handling a large number of cases and it has been evaluated by comparing the numerical results of some specific cases (the cases of circular and elliptic holes) with the available experimental results. (auth)

2212 RISK OF RUPTURE OF REACTOR PRESSURE VESSELS AND PIPES. Wellinger, K.; Kraegeloh, E.; Kussmaul, K.; Strum, D. (Univ., Stuttgart). Nucl. Eng. Des.; 20: No. 1, 215-35(1972). (In German).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

By proper material selection, design and analysis, together with the applicable material testing-methods, bursting of pressure-vessels and pipings may be excluded, even if the components contain material defects to a certain degree. The methods of strength calculation applied are based on the ability of the material to deform plastically, which must be guaranteed under all service conditions and possible states of the material. Unanswered questions in the field of safety-analysis are discussed. Some of these concern embrittlement phenomena caused by unfavorable states of stress—i.e., with multi-axial residual tensile stresses, so far not considered in fracture mechanics—, as well as the effective material properties in the finished structural component (basic material, welded joints with local embrittlement and/or stress-relief embrittlement) including the influence of service conditions and the question of the allowable maximum nominal stress. In the case of seamless and normalized or quenched and tempered uncomplicated structure members, there exist relatively simple relationships between specimens or models and the real component. This is generally not true for thick-walled and/or welded structures even if the latter are stress-relief heat-treated. Such structures may collapse at nominal stresses far below the yield stress, as soon as a critical value of the residual stresses is exceeded if simultaneously unfavorable material conditions exist. These statements are based on tests with unnotched and notched plates, pipes and pressure vessels with liquid and gaseous pressure media under static or repeated loading, as well as on the analysis of damaged components. (auth)

2213 MATRIX DISPLACEMENT METHODS IN FRACTURE MECHANICS ANALYSIS OF REACTOR VESSELS. Rowe, G. H. (Univ., Stuttgart). Nucl. Eng. Des.; 20: No. 1, 251-63(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

The technology of fracture mechanics is developing rapidly in response to increased requirements for integrity of engineering structures. It enables structural engineers to evaluate brittle

failure resistance of structures within appropriate regimes of temperature, materials and geometry. The evaluation includes the combined effects of material toughness, flaw characteristics, environment and service loadings. Calculations of stress intensity factors associated with the flaws, geometry and applied loading form the basis of fracture analysis and control procedures for reactor vessels. With the corresponding rapid development and acceptance of the matrix displacement method (finite element method) for structural analysis, attention is being given to the use of this method in fracture analysis. Modern computers have made the matrix displacement method of structural analysis a convenient method for determination of stresses and displacements in complex structures. For structures containing cracks, calculation of the stress field in the immediate vicinity of a crack tip is limited by the crack tip stress singularity. Various schemes have been proposed to overcome this limitation. Continued development of the finite element methods for stress intensity factors should lead to experience and confidence in the methods and their acceptance as a practical tool in the fracture analysis of reactor vessels. (auth)

2214 PREVENTION OF FRACTURE INITIATION IN REACTOR STRUCTURAL MATERIALS. Nichols, R. W.; Cowan, A. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Nucl. Eng. Des.; 20: No. 1, 287-302(1972).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971). See CONF-710903-(Vol.20,No.1).

The integrity of pressure retaining circuits in nuclear reactor systems is dependent on their tolerance to defects. When the size of a defect and its stress field reach a critical value, fast unstable fracture will occur. The relationship between defect size and stress field is brought together by the science of fracture mechanics. For materials failing under brittle conditions linear elastic fracture mechanics has been developed and applied, especially in U.S.A. to the fracture of from 200 to 300-mm thick steel pressure vessels for PWR and BWR systems. For materials which fail under more ductile conditions (non-plane strain) general yield fracture mechanics, utilizing a critical value of crack opening displacement (C.O.D.), is more applicable. This C.O.D. approach has been developed in terms of testing technique and its applicability to structures. Data are presented which demonstrate the test method as an extension of that used in linear elastic fracture mechanics test methods and, from tests on wide plates and pressure vessels, confirm the validity of the C.O.D. concept. Its direct use in reactor technology is exemplified in considering failure conditions in zirconium-alloy pressure tubes in the Steam Generating Heavy Water Reactor (S.G.H.W.R.). C.O.D. test pieces are used for surveillance of embrittlement due to neutron damage and hydrogen pick-up and the C.O.D. values from such specimens have shown good agreement with the measured failure conditions of experimentally irradiated pressure tubes. It is concluded that general yield fracture mechanics offer a viable concept of quantifying failure conditions in the more ductile materials. Whilst fracture mechanics permits a good prediction of failure conditions of materials, its application is dependent upon a knowledge of stress fields and actual defect sizes in structures. Defects may be found and quantified by non destructive testing before service. During reactor operation growth to the critical size may occur by pressure cycling, thermal cycling, stress corrosion etc. Such growth should be quantified by periodic inspection of the structure during service. The use of surveillance test pieces permits the changes in toughness due to service conditions to be evaluated throughout reactor life; knowledge, by direct measurement, of changing defect sizes in the structure permits the safe remaining life to be calculated. (auth)

2215 STRUCTURAL MECHANICS IN REACTOR TECHNOLOGY. SEISMIC ANALYSIS, CONCRETE PRESSURE VESSELS. First International Conference, Berlin, Germany, September 20–24, 1971. Nucl. Eng. Des.; 20: No. 2, 303-590 (1972). (In French and English). (CONF-710903-(Vol.20,No.2)).

Eleven papers were presented at the conference and are included in this issue. A separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 257, 1947, 2029–2031, and 2146–2151.

Reactor Physics and Core Engineering

Physics

Refer also to abstracts 1505 and 1515.

2216 (ANL-7910) APPLIED PHYSICS DIVISION ANNUAL REPORT, JULY 1, 1970 TO JUNE 30, 1971. (Argonne National Lab., Ill.). Jan 1972. Contract W-31-109-eng-38. 548p. Dep. NTIS.

Included are 5 sections on nuclear reactions and cross sections, fast reactor physics, reactor physics experimental facilities, instrumentation, and computation methods and theory. A separate abstract was prepared for each section. (H.D.R.)

For abstracts of individual sections see: 1638, 1948, 2181, 2217, and 2238.

2217 (ANL-7910, pp 427-521) REACTOR COMPUTATION METHODS AND THEORY. Jan 1972.

In Applied Physics Division annual report, July 1, 1970 to June 30, 1971.

To a large degree, the quality of reactor design and performance depends upon the quality of the conceptual models and their portrayal in accurate mathematical representation, and upon the quality and efficiency of computational methods. A priori, the continuous development and refinement of theory and computational methods leads to the design of more dependable, safer, and better performing reactors. It is with this intent that the studies described were undertaken. (auth)

2218 (CISE-R-244) MOICANO-2: A DIGITAL COMPUTER PROGRAM FOR FUEL CYCLE STUDIES. PART 1: THE DESCRIPTION OF THE CALCULATIONAL MODEL. Bruschi, C.; Foresti, G.; Goldaniga, G.; Piazza, G. (Centro Informazioni Studi Esperienze, Milan (Italy)). May 1968. 115p. INIS.

Declassified 1971.

The MOICANO-2 code studies the problem of calculating equilibrium cycle continuous refueling in (r,z) geometry, with two-group diffusion approximation. An important feature of the code is that it performs the thermal-hydraulic design. Such a calculation of the code gives channel flow rates, enthalpies, pressure at different points in the plant and the coolant density and fuel temperature distribution in the core which are consistent with the power distribution relative to the fuel cycle considered. At the end the code calculates the isotope concentration of the discharged fuel and the reactivity held by the coolant and that held by xenon and rhodium. In addition the code performs some rough economic evaluations. The code was written in FORTRAN 4 for an IBM 7040. (INIS)

2219 (CISE-R-255) COMPUTER CODE SPAD. A STUDY OF SPACE-TIME REACTOR KINETICS BEHAVIOUR. Brusa, L.; Giorcelli, M. (Centro Informazioni Studi Esperienze, Milan (Italy)). Jun 1968. 96p. INIS.

Declassified 1971.

SPAD is a code written in FORTRAN 4 for the IBM 7040 computer aimed at calculating the space-time behavior of the neutron flux in a nuclear reactor during power transients. It is based on diffusion theory, in a two energy group approximation; x-y coordinates are used. The number of delayed neutron groups may be chosen from 1 to 6. The diffusion equations are numerically integrated. Suitable subroutines can be easily introduced to describe external perturbations and/or feedback effects by means of time dependent changes in the parameters of the diffusion equations. The subroutines included at present are mainly aimed to the treatment of safety evaluation problems associated with pressure-tube reactors with a positive void coefficient. Instructions for the preparation of input data are included as well as a listing of the program. (INIS)

2220 (CISE-R-272) INCHEY: A TWO-DIMENSION HETEROGENEOUS CODE FOR PERIODICAL INFINITE GEOMETRIES. Bruschi, C.; Pedretti, F. (Centro Informazioni Studi Esperienze, Milan (Italy)). Feb 1969. 29p. (In Italian). INIS.

Declassified 1971.

The difficulty in applying heterogeneous techniques in a reactor with a large number of channels is the memory capability of digital computers. However the case of an infinite lattice may be easily treated with a heterogeneous model. This lattice configuration permits not only the calculation (typically heterogeneous) of control rods placed periodically in the lattice, but also a useful comparison with results from heterogeneous calculations. (INIS)

2221 RAM-1: MONTE CARLO CODE FOR THE CALCULATION OF EFFECTIVE LOGARITHMIC BOUNDARY CONDITION AT THE SURFACE OF CONTROL RODS. Szatmary, Z.; Bagyinszki, A. (Central Research Inst. for Physics, Budapest). Kernenergie; 15: No. 2, 41-7(Feb 1972).

In the few-group diffusion code SISYPHUS an effective logarithmic boundary condition can be taken into account at the boundary of regions where the diffusion approximation is not valid. RAM-1 calculates the value of the logarithmic derivative of the flux at the boundary of such regions using Monte Carlo techniques in the thermal group. Slowing down inside the region can be taken into account. (auth)

2222 REACTOR TECHNOLOGY. VOLUME 15, NUMBER 3. One of Four Technical Progress Reviews Published for the Technical Information Center, USAEC. Washington, D. C.; Atomic Energy Commission (1972). 61p. $0.75.

Included are 2 papers on low-cycle fatigue of reactor structural materials and the use of flux synthesis methods in reactor physics. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 829 and 2223

2223 FLUX SYNTHESIS METHODS IN REACTOR PHYSICS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Reactor Technol.; 15: No. 3, 210-38(1972).

Use of flux synthesis methods to compute the neutron distribution and other important parameters in nuclear reactors is reviewed. Spatial, spectral, and angular synthesis methods are discussed. Examples are described which illustrate common methods of selecting trial functions and which represent the current state of the art. Recent advances in the underlying theory and in the development of specific applications are discussed, experience with the different synthesis methods is assessed, and promising areas for further development activity are suggested. 141 references. (auth)

Core Thermal Hydraulics

2224 PROBABILITY OF NUMBER OF HOT SUBASSEMBLY BY ORDER STATISTICS. Miyamoto, Yoshiaki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 8, 499-501(Aug 1972).

To assess the performance of nuclear reactor cores, it is of interest to know the number of fuel element subassemblies whose temperatures exceed certain limits (hot subassemblies). A method to evaluate the probability of the number of hot subassemblies using order statistics is proposed. (H.D.R.)

GENERAL

Information Handling

2225 (LA-5020) PATRICIA II: TWO LEVEL OVERLAYED INDEXES FOR LARGE LIBRARIES. Clark, J. L. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 89p. Dep. NTIS.

Thesis. Submitted to Univ. of New Mexico, Albuquerque.

PATRICIA is a Practical Algorithm To Retrieve Information Coded In Alphanumeric. The library index built by PATRICIA is entirely core resident. PATRICIA-II extends PATRICIA by building both a lower index and an upper index. This allows for the indexing of a much larger library. The lower index is core resident and the upper index is divided into upper pages which are stored on disk. At any given time only the lower index and one upper page are in core. Upper pages reference only themselves, not each other. In addition to these innovations, PATRICIA-II retains all of the features of its predecessor. When new material is added to the library, it is not necessary for the library text or the corresponding index to be rearranged. When keys are presented to the system, the time spent in determining the presence or absence of a corresponding target is a function of the length of the key and the number of occurrences of the key. PATRICIA-II has been implemented as a FORTRAN program on the CDC-6600 and 7600. (auth)

Law

2226 ENVIRONMENTAL LAW: A CHALLENGE TO THE LEGAL PROFESSION. Doub, William O. (Atomic Energy Commission, Washington, D. C. Pub. Util. Fortn.; 90: No. 7, 68-71(28 Sep 1972).

Reasons for devoting more attention to aspects of environmental law are discussed. Enactment and effects of the National Environment Policy Act are discussed along with challenges to AEC licensing procedures. It is noted that environmental law as a specialty has come of age and those who engage in that necessary practice should be subject to the same discipline and codes as those practicing in other areas. (J.R.D.)

2227 1971 ANNUAL REPORT ON THE ADMINISTRATION OF THE RADIATION CONTROL FOR HEALTH AND SAFETY ACT OF 1968. MESSAGE FROM THE PRESIDENT OF THE UNITED STATES TO NINETY SECOND CONGRESS, SECOND SESSION, AUGUST 2, 1972. Washington, D. C.: Joint Committee on Atomic Energy (1972). 115p.

The Food and Drug Administration's Director of the Bureau of Radiological Health was delegated the authority for the day-to-day administration of the Public Health Service Act (P.L. 90-602) on June 4, 1969. This report covers the detailed operation of the Bureau in carrying out that responsibility for calendar year 1971. Preliminary estimates are available from the U. S. Public Health Service 1970 X-ray Exposure Study, conducted by the Bureau of Radiological Health in cooperation with the National Center for Health Statistics. The annual estimates include the number and rate of persons x-rayed by selected demographic characteristics, the number and rate of patient visits during which x-ray equipment was used, the distribution of x-ray examinations and procedures by type of facility, and the number of films exposed during patient examinations. These estimates will be compared with data from the 1964 X-ray Exposure Study in continuing detailed studies to identify changes in practice during the 6-year period. A general report containing final estimates on the exposure studies will be published in the spring of 1972. This will be followed by a report on gonad and genetically significant dose estimates in the summer of 1972. In the experimental and human epidemiologic research program, priority was given to expanding the study of microwave radiation effects and continuing the investigation of biological and health effects of x rays. A proposed performance standard for diagnostic x-ray equipment and their major components was published as a Notice of Proposed Rule Making in the FEDERAL REGISTER on October 8, 1971. Three performance standards are now in effect: television receivers; demonstration-type cold-cathode gas discharge tubes; and microwave ovens that went into effect October 6, 1971. A review and evaluation of the Department's reports and record-keeping activities and compliance actions related to P. L. 90-602 is detailed. Compliance actions involved domestic and imported television receivers and components, cold-cathode tubes, x-ray equipment, and microwave ovens. Problems in the development, implementation, and evaluation of several standards and the compatibility of Federal standards and State regulations are discussed. Equipment research activities were carried out in the fields of ionizing radiation, ultrasonic radiation, microwave radiation, and laser radiation. An Electronic Product Information System (EPIS) that stores and retrieves information on electronic products and on manufacturers of electronic products subject to P. L. 90-602 has been operational since July 1971. A listing of 16 research activities in the field of medical radiation exposure is presented. (auth)

Mathematics and Computers

2228 (SC-DR-720201) PROGRAM PLOTEM. Guy II, W. F. (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 117p. Dep. NTIS.

Program PLOTEM produces plots of various combinations of the calculated raw data stored in permanent data tapes by EDIT 1 and EDIT 2 for processing semiconductor radiation effects data. PLOTEM is in FORTRAN IV for the COC-6600. (W.H.K.)

Miscellaneous

2229 (ACRH-1000-356) COMPUTER SIMULATION OF SMALL BLOOD VESSEL IMAGING IN MAGNIFICATION RADIOGRAPHY. Doi, Kunio; Rossmann, Kurt (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 26p. (CONF-720457-2). Dep. NTIS.

From Symposium on small vessel angiography; Glen Cove, NY. (Apr 1972).

2230 (ACRH-1000-359) IMMUNOSUPPRESSION. Fitch, F. W.; Rowley, D. A. (Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 24p. (CONF-720652-1). Dep. NTIS.

From Conference on inflammation; Princeton, NJ. (8 Jun 1972).

2231 (ACRH-1000-365) EFFECT OF THE X-RAY SPECTRUM AND SCREEN-FILM UNSHARPNESS ON THE IMAGING OF BLOOD VESSELS. Haus, A. G.; Rossmann, K. (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 21p. (CONF-720457-1). Dep. NTIS.

From Symposium on small vessel angiography; Glen Cove, NY. (Apr 1972).

2232 (ACRH-1000-366) WHOLE-BODY RADIOGALLIUM SCANNING FOR STAGING OF HODGKIN'S DISEASE AND OTHER LYMPHOMAS. Hoffer, P. B.; Turner, David; Gottschalk, Alexander; Harper, P. V.; Ultmann, J. E. (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill.). 1972. 24p. (CONF-720338-1). Dep. NTIS.

From Hodgkin's symposium; Stanford, CA. (Mar 1972).

2233 (ACRH-1000-376) ON THE STRUCTURE OF HUMAN SERUM LOW- AND HIGH-DENSITY LIPOPROTEINS. Scanu, A. M. (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 49p. (CONF-720719-1). Dep. NTIS.

From CIBA Foundation Symposium in London, England (6 Jul 1972).

2234 (ACRH-1000-377) APPLICATION OF THE TECHNIQUE OF ISOELECTRIC FOCUSING TO THE STUDY OF HUMAN SERUM LIPOPROTEINS AND THEIR APOPROTEINS. Scanu, A. M.; Edelstein, Celina; Aggerbeck, Lawrence (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 36p. (CONF-720557-1). Dep. NTIS.

From Isolation focusing meeting; New York, NY. (15 May 1972).

2235 (ACRH-1000-380) PROTEIN SYNTHESIS IN WORK-OVERLOADED MYOCARDIUM. Zak, R.; Dowell, T.; Martin, A. F.; Rabinowitz, M. (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). 1972. 15p. (CONF-720336-1). Dep. NTIS.

From Symposium on heart-overloading; Paris, France (14 Mar 1972).

2236 (AECL-3960) DNA CONTENT VARIATION, PLOIDY LEVELS AND RELATIONSHIPS WITHIN THE GENUS ROSA IN MANITOBA. El-Lakany, M. H. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1972. 12p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

2237 (AERE-R-6637) DEPOSITION OF LIQUID OR SOLID DISPERSIONS FROM TURBULENT GAS STREAMS: A STOCHASTIC MODEL. Hutchinson, P.; Hewitt, G. F.; Dukler, A. E. (Atomic Energy Research Establishment, Harwell (England)). Dec 1970. 46p. Dep. NTIS (U. S. Sales Only).

2238 (ANL-7910, pp 523-35) MISCELLANEOUS. Jan 1972.
In Applied Physics Division annual report, July 1, 1970 to June 30, 1971.
ARGONNE RESEARCH REACTOR—core loading for, physics analysis of modified
GAMMA RADIATION—spectra measurements by solid-state detectors, computer codes for unfolding Compton continuum
REACTOR FUEL ELEMENTS—assay of, dual spectrum facility concept for
THERMONUCLEAR REACTORS—performance of, power balance parameters for analysis of
VENTILATION—methods for urban air conditioning, nonelectrical or off-peak electrical (H.D.R.)

2239 (ANL-7953) DEVELOPMENT OF HIGH-SPECIFIC-ENERGY BATTERIES FOR ELECTRIC VEHICLES. Progress Report, February 1972-July 1972. Cairns, E. J.; Gay, E. C.; Steunenberg, R. K.; Shimotake, H.; Selman, J. R.; Wilson, T. L.; Webster, D. S. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 114p. Dep. NTIS.

2240 (BDX-613-779) BEAM LEAD DEVICES AND THE HMC MANUFACTURER. Markley, R. E. (Bendix Corp., Kansas City, Mo.). 1972. Contract AT(29-1)-613. 18p. (CONF-721016-2). Dep. NTIS.
From Mid-America electronics conference; Kansas City, Mo. (26 Oct 1972).

2241 (BNL-16652) MODEL: A DIGITAL SIMULATION AND DESIGN AUTOMATION LANGUAGE. Peskin, Arnold M. (Brookhaven National Lab., Upton, N. Y.). 1972. 25p. (CONF-721105-1). Dep. NTIS.
From Fall joint computer conference '72; Las Vegas, NV. (13 Nov 1972).

2242 (BNL-17088) DEFINED MUTANTS IN HIGHER PLANTS. Carlson, P. S.; Dearing, R. D.; Floyd, B. M. (Brookhaven National Lab., Upton, N. Y.). 1972. 19p. (CONF-721102-1). Dep. NTIS.
From twelfth international symposium on basic biology; Cali, Colombia (27 Nov 1972).

2243 (BNL-17102) SINGLE PARTICLE DENSITY FUNCTION IN THE bcc PHASE OF ^{4}He. Kitchens, T. A. (Brookhaven National Lab., Upton, N. Y.). Jul 1972. 12p. (CONF-720833-19). Dep. NTIS.
From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).
physics (low-temperature) 20M

2244 (BNL-17160) TOWARDS A PARASEXUAL CYCLE IN HIGHER PLANTS. Carlson, Peter S. (Brookhaven National Lab., Upton, N. Y.). [nd]. 14p. (CONF-720946-1). Dep. NTIS.
From Symposium in plant protoplasts; Versailles, France (11 Sep 1972).

2245 (BNL-17174) AEROSOL CHEMISTRY. Castleman, A. W. Jr. (Brookhaven National Lab., Upton, N. Y.). [nd]. 26p. (CONF-720721-1). Dep. NTIS.
From Chemistry and physics of upper atmospheres meeting; Orleans, France (31 Jul 1972).

2246 (BNL-17180) ALTERATIONS IN SKELETAL MASS IN ENDOCRINE DYSFUNCTIONS AS DETERMINED BY TOTAL-BODY NEUTRON ACTIVATION ANALYSIS. Cohn, S. H.; Roginsky, M. S.; Aloia, J. F.; Ellis, K. J.; Shukla, K. K. (Brookhaven National Lab., Upton, N. Y. Nassau County Medical Center, East Meadow, N. Y. (USA)). 1972. 8p. (CONF-721020-1). Dep. NTIS.
From 9th European symposium on calcified tissues; Baden, Austria (1 Oct 1972).

2247 (BNL-17216) MODEL GENETIC SYSTEMS FOR STUDYING MUTATION, DIFFERENTIATION, AND SOMATIC CELL HYBRIDIZATION IN PLANTS. Smith, H. H. (Brookhaven National Lab., Upton, N. Y.). 1972. 17p. (CONF-721034-1). Dep. NTIS.
From Meeting on improvement of mutation breeding techniques; Bari, Italy (6 Oct 1972).

2248 (CALT-767-P-6-X-8) STUDIES IN DEVELOPMENTAL IMMUNOGENETICS. Annual Progress Report. Owen, R. D. (California Inst. of Tech., Pasadena. Div. of Biology). 4 Aug 1972. Contract AT(04-3)-767. 13p. Dep. NTIS.

2249 (CEA-R-4277) HARMONIC ANALYSIS OF THE SPONTANEOUS ELECTRICAL ACTIVITY IN THE RABBIT BRAIN DURING HYPOXIA. Barbey, Patrick; Flavigny, Renee (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1972. 98p. (In French). Dep. NTIS (U. S. Sales Only).

2250 (CEA-R-4353) ELECTRICAL PROPERTIES OF LANTHANUM ORTHOCHROMITE. Roux, Madeleine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1972. 50p. (In French). Dep. NTIS (U. S. Sales Only).

2251 (CONF-720655-1) FOREST MANAGEMENT AND LAND USE CONFLICTS: A CASE STUDY OF RESOURCE MANAGEMENT. Peelle, Elizabeth (Oak Ridge National Lab., Tenn.). 1972. 39p. Dep. NTIS.
From National commission on materials policy and Georgia Institute of Technology University forum conference; Atlanta, GA. (26 Jun 1972).

2252 (CONF-720937-1) VISUALIZATION OF RNA SYNTHESIS. Hamkalo, B. A.; Miller, O. L. Jr.; Bakken, A. H. (Oak Ridge National Lab., Tenn. Tennessee Univ., Oak Ridge (USA). School of Biomedical Sciences). [nd]. 27p. Dep. NTIS.
From seventh national cancer conference; Los Angeles, CA. (27 Sep 1972).

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